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ENGINEERING:

An Illustrated Weekly Journal.

EDITED BY WILLIAM H. MAW AND ALEX. RICHARDSON.

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See Illustrated Advertisement
Page 135, Oct. 8.

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See page 17, Oct. 8. 3206

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See page 15, Oct. 8. 3421

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See Illus. Advt. last week, page 15. 3902

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See Advertisement page 26. 6167

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See Advertisement page 100, Oct. 8. 3402

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See half-page Advertisement page 90, Oct. 1.

See Advt. Page 128, Oct. 8.
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TENDERS.

THE SOUTH INDIAN RAILWAY COMPANY, LIMITED, are prepared to receive

Tenders for the Supply of :—

STEEL AXLES for LOCOMOTIVES (934) and ROLLING STOCK.

Specifications and Forms of Tender may be obtained at the Company's Offices, 91, York Street, Westminster, S.W. 1.

Tenders, addressed to the Chairman and Directors of the South Indian Railway Company, Limited, marked "Tender for Steel Axles," must be left with the undersigned not later than Two p.m. on Tuesday, the 26th October, 1920.

A charge, which will not be returned, will be made of 2s. for each copy of the Specification. Copies of the drawings may be obtained at the Office of Robert White, Esq., M.Inst.C.E., Consulting Engineer to the Company, 3, Victoria Street, Westminster, S.W.

By Order,
W. B. REYNOLDS,
For Managing Director.
91, York Street, Westminster, S.W. 1.
8th October, 1920. K 201

CLYDE NAVIGATION.

GRABS FOR SALE.

The Trustees of the Clyde Navigation invite

Offers for Ten Surplus Grabs,

as they lie at Glasgow Harbour, for dealing with ore or coal. The Grabs, including suspenders, are of the single-chain type with removable teeth, of a capacity of a cubic yard and a half, and weigh 50 cwts. each. They may be inspected at any time by arranging with the Mechanical Engineer.

Offers for one or more of the Grabs to be lodged with the undersigned on or before Monday, 25th October, 1920.

The Trustees may not accept the highest or any offer.

T. R. MACKENZIE,
General Manager and Secretary.
16, Robertson Street, Glasgow,
11th October, 1920. K 236

BURMA RAILWAYS COMPANY, LIMITED.

The Board of Directors of the Burma Railways Company Limited, are prepared to receive

Tenders for the Supply of :—

700 HELICAL SPRINGS.

For each copy of the Specification a fee of 10s. will be charged, which fee is not returnable. Tenders enclosed in sealed envelopes addressed to the "Chairman and Directors" and endorsed "Tender for Helical Springs" must be delivered at the Company's Offices not later than 12 noon on Friday, 22nd October, 1920. The Directors do not bind themselves to accept any or the lowest Tender and reserve the right to divide the order.

The Springs are urgently required in Burma.

By order of the Board.
W. HOME,
Managing Director.
199, Gresham Street,
Old Broad Street,
London, E.C. 2.
12th October, 1920. K 267

CITY OF MANCHESTER.

The Electricity Committee of the Manchester Corporation are prepared to receive

Tenders in Connection with

the CONSTRUCTION of their BARTON POWER STATION, Trafford Park, Manchester, for :—

Contract No. 4.—STEELWORK in TURBINE HOUSE and SWITCH HOUSE.

Specification, Quantities, and Form of Tender may be obtained on application to Mr. F. H. Hughes, Secretary, Electricity Department, Town Hall, Manchester, on payment of a deposit of £2 2s., which amount will be refunded on receipt of a bona-fide Tender.

Drawings may be seen at the offices of Messrs. C. S. Allott & Son, Civil Engineers, 4s, Brown Street, Manchester.

Tenders, duly endorsed and addressed to the Chairman of the Electricity Committee, must be delivered at the Town Hall not later than Ten a.m., on Wednesday, the 27th October, 1920.

The Firm entrusted with this work will be required to enter into a contract to be prepared by the undersigned.

The Corporation do not bind themselves to accept the lowest or any Tender.

THOMAS HUDSON,
Town Clerk.
Town Hall,
Manchester.
11th October, 1920. K 253

COUNTY BOROUGH OF BURNLEY.

HURSTWOOD RESERVOIR FILTERS.

Tenders are Invited for Com-

PLETE INSTALLATION of MECHANICAL PRESSURE FILTERS at Hurstwood Reservoir, Burnley. For particulars, apply to Messrs. JAMES DIGGLE & SON, Civil Engineers, 14, Brown Street, Manchester. Tenders, endorsed "Hurstwood Filters," to be forwarded to the undersigned not later than the 27th instant.

J. D. RITCHIE,
Town Clerk's Office, Town Clerk.
Burnley.
8th October, 1920. K 218

ABERDEEN CORPORATION WATER WORKS.

EXTENSIONS, 1920.

Contract No. 2—
ADDITIONAL STORAGE RESERVOIR.

The TOWN COUNCIL OF ABERDEEN are prepared to receive

Tenders from Competent

Persons willing to enter into a Contract for the CONSTRUCTION of a STORAGE RESERVOIR and Ancillary Works at Invercannie, near Banchory Railway Station.

The work comprises about
70,000 cub. yds. Excavation.
18,000 cub. yds. Concrete.
30,000 sq. yds. Asphalting.

The Drawings may be inspected, and Specifications, Schedules of Quantities, and Forms of Tender obtained on and after 18th October, 1920, on application at the Water Engineer's Office, 41½, Union Street, Aberdeen.

For each Specification a deposit of Five pounds sterling in cash will be required, which sum will, after a tender has been accepted, be returned to the Tenderer, provided that he shall have sent in a bona fide tender, based on the Drawings, Specification and Schedule of Quantities provided, with the Schedule of Quantities and other Schedules fully priced out in detail and shall not have withdrawn the same. Provision is made for adjustment of the contract sum to meet alterations in the cost of labour and materials.

The site may be inspected at any time by appointment.

Tenders on the Forms prescribed and enclosed in securely sealed envelopes, endorsed "Tender for Storage Reservoir" and addressed to the undersigned, must be delivered not later than 5th November, 1920.

The Town Council do not bind themselves to accept the lowest or any Tender.

GEORGE MITCHELL, M.I.Mech.E.,
Water Engineer.
Water Engineer's Office,
41½, Union Street, Aberdeen.
1st October, 1920. K 130

TO CONTRACTORS.

BELFAST WATER WORKS.

MOURNE SCHEME.

Contract A.

For the Construction of the
"SILENT VALLEY" STORAGE RESERVOIR, &c.

The Belfast City and District Water Commissioners are prepared to receive

Tenders from Competent

CONTRACTORS for the CONSTRUCTION of the "SILENT VALLEY" STORAGE RESERVOIR, &c., in the MOURNE MOUNTAINS, County Down, having an Earthen Embankment about 1,600 ft. long and 90 ft. high, and a storage capacity of 3,000 million gallons, with an Outlet Tunnel, Waste Channel, and other auxiliary works, also the construction of a temporary Works Railway.

The Contract Drawings and Specification have been prepared by the Commissioners' Chief Engineer, Mr. F. W. M'Cullough, M.Inst.C.E., Water Office, Royal Avenue, Belfast, and may be inspected at his Office on any weekday (except Saturday), between the hours of Ten a.m. and Five p.m.

Duplicate Copies of the Specification and Form of Tender, &c., may be obtained from the undersigned upon payment of the sum of Five Guineas. This sum will only be repaid by the Commissioners after the receipt of a *bona fide* Tender which has not been withdrawn.

On the Tuesday and Friday of each week, commencing with Tuesday, the 26th inst., an Assistant Engineer will meet intending Contractors at the Engineer's Office, at Ten o'clock forenoon, and accompany them to the site of the proposed Works.

Tenders, sealed and endorsed "Tender for Silent Valley Storage Reservoir, &c.," must be delivered by registered post, and addressed to the undersigned, not later than Three p.m. on Wednesday, 3rd November, 1920.

The Commissioners do not bind themselves to accept the lowest or any Tender, nor will they be responsible for any expenses incurred in making out a Tender.

W. I. QUINN,
Secretary,
Water Office, Royal Avenue,
9th September, 1920. Belfast. J 187

TO CONTRACTORS.

BELFAST WATER WORKS.

MOURNE SCHEME.

Contract A.

For the Construction of the
"SILENT VALLEY" STORAGE RESERVOIR, &c.

SCHEDULE OF QUANTITIES.

A Detailed "Schedule of

QUANTITIES" has been prepared by me for the above Extensive Storage Reservoir and other Works in the Mourne Mountains, County of Down. Contractors wishing to Tender for this work will be supplied with Printed Copies of the "Schedule of Quantities" on application and payment to me of the sum of Three Guineas per Copy, which sum will not be repayable.

ACHESON FERGUSON,
Quantity Surveyor,
Scottish Provident Buildings,
9th September, 1920. Belfast. J 188

JAMNAGAR DWARKA RAILWAY COMPANY LIMITED.

Tenders are Invited for the

SUPPLY of FIVE MILES of 14 lb. PORTABLE RAILWAY TRACK. Forms of Tender, Schedules and Specifications, with General Conditions of Contract, may be obtained from the Consulting Engineers, Messrs. RENDEL, PALMER & TRITTON, 15, Dartmouth Street, Westminster, S.W. 1, on payment of the sum of £1 1s. 0d. (which will not be returned). Tenders must be delivered at the above address not later than Noon on Wednesday, 27th October, 1920. K 206

METROPOLITAN BOROUGH OF HAMMERSMITH.

SECOND-HAND MACHINERY.

The Borough Council invite

Offers for the Supply, in

good order, of the following SECOND-HAND MACHINERY :—

One Tubular Oil Cooler, suitable for 2000 Kw. Turbo Generator, with pump for forced lubrication.

One Steam Reciprocating Lift Pump, capable of lifting 4000 gallons of water per hour, against a head of 50/60 ft.

One Rectangular Galvanised Iron or Steel tank, 8 ft. by 6 ft. by 10 ft., or similar capacity.

One Tray, Chain or Plate Conveyer for coal, complete with supports, rollers and gear, about 160 ft. between centres.

Further particulars may be obtained from Mr. G. G. Bull, Borough Electrical Engineer, Electricity Works, 85, Fulham Palace Road, W. 6.

Offers, endorsed "Second-Hand Machinery," must be delivered to the Borough Electrical Engineer, at the address above stated, not later than Nine a.m. on FRIDAY, 29th October, 1920.

The Council do not bind themselves to accept the lowest or any offer.

LESLIE GORDON,
Town Clerk.
Town Hall,
Hammersmith, W. 6.
12th October, 1920. K 267

METROPOLITAN WATER BOARD.

TENDERS FOR THE CONSTRUCTION OF COVERED SERVICE RESERVOIR AT BROMLEY, KENT.

The Metropolitan Water Board invite

Tenders for the Construction

of a COVERED SERVICE RESERVOIR of a capacity of about five million gallons at Bromley situate in the Parish of Bromley, in the County of Kent.

Drawings, Conditions of Contract, and Specification, may be inspected at the Offices of the Board (Chief Engineer's Department), 173, Rosebery Avenue, Clerkenwell, E.C., on and after Monday, 11th October, 1920.

Forms of Tender, Conditions of Contract, Specification, Bills of Quantities, and copies of the Contract Drawings, together with a spare copy of the Bills of Quantities, may be obtained from the Chief Engineer on production of an official receipt for the sum of £10, which sum must be deposited with the Accountant to the Board at 173, Rosebery Avenue, Clerkenwell E.C. 1. and will be returned on receipt of a *bona fide* Tender together with all the above named documents, with the exception of the spare copy of the Bills of Quantities which may be retained by the tenderer. Such payments and applications must be made between the hours of Ten a.m. and Four p.m., except Thursdays and Saturdays.

Tenders enclosed in sealed envelopes addressed to "The Clerk of the Board, Metropolitan Water Board, 173, Rosebery Avenue, Clerkenwell, E.C. 1," and endorsed "Tender for Reservoir at Bromley," must be delivered at the Offices of the Board not later than Ten a.m. on Monday, 1st November, 1920.

The Board do not bind themselves to accept the lowest or any Tender.

A. B. PILLING,
Clerk of the Board.
Offices of Board,
173, Rosebery Avenue,
Clerkenwell, E.C. 1.
30th September, 1920. K 155

CITY AND COUNTY OF BRISTOL.

NEW ROAD, BRISTOL TO AVONMOUTH.

CONTRACT NO. 1.
EARTHWORKS, TEMPORARY BRIDGES AND SURFACE WATER DRAINAGE.

TO CONTRACTORS.

The Corporation of the City and County of Bristol invite

Tenders for the Earthworks

and DRAINAGE of FOUR SECTIONS of this NEW ROAD, about 1¼ miles in length situated between the West side of Shirehampton Park and Irishman's Cottages, Hotwells, including a cutting 935 yards long and from 40 to 50 feet deep, forming embankments and constructing two Temporary Bridges, one across the valley of the River Trym at Sea Mills and the other across the Great Western and Midland Railway Companies Joint line.

It is intended at a later date of which due notice will be given to invite Tenders for the work in connection with the diversion of Bridge Valley Road, Hotwells, and the construction of four river walls on the banks of the River Avon.

A Form of Tender, General Conditions, Specification and Bill of Quantities may be obtained at the City Engineer's Office, 63, Queen Square, Bristol, on or after Saturday the 16th October, 1920, on deposit of a cheque value five guineas which will be returned on receipt of a bona fide Tender. The drawings may be examined at the same office.

Tenders made out on the forms supplied, in accordance with the printed instructions enclosed and sealed in the envelopes provided, must be delivered at the City Engineer's Office, 63, Queen Square, Bristol, not later than ten a.m. on Saturday the 30th October, 1920.

The Corporation do not bind themselves to accept the lowest or any Tender.

By Order,
LESSEL B. McKENZIE,
City Engineer.
City Engineer's Office,
63, Queen Square, Bristol.
15th October, 1920. K 275

APPOINTMENTS OPEN.

CITY AND GUILDS (ENGINEERING) COLLEGE.

DEPARTMENT OF MECHANICS AND MATHEMATICS.

Two Demonstrators Required,

the work consists of teaching and class work. Total stipend £370 a year. Applications and statement of qualifications to be sent to Professor Forsyth, F.R.S., Imperial College of Science and Technology, South Kensington, S.W., not later than 18th October, 1920. K 143

WIGAN AND DISTRICT MINING AND TECHNICAL COLLEGE.

Applications are Invited for

the following vacancies :—
Lecturer in Mechanical Engineering.
Lecturer in Electrical and Mechanical Engineering.
Salary Scale :—
Grade I. £160—£10—£280.
Grade II. £240—£10—£290—£15—£500.

In fixing initial salary full allowance will be made for years of service in teaching or in industry.

Particulars may be had from the PRINCIPAL, to whom applications should be sent as early as possible. K 241

WOLVERHAMPTON EDUCATION COMMITTEE.

MUNICIPAL TECHNICAL SCHOOL.

Required, as Early as Possible

a FULL-TIME LECTURER in MECHANICAL ENGINEERING. University Degree, or its equivalent, and teaching experience essential. Salary £300, rising by annual increments of £25 to a maximum of £400. Application form and further particulars can be obtained upon sending stamped addressed foolscap envelope to the undersigned. Applications must be received by not later than 27th October, 1920.

T. A. WARREN,
Director of Education.
Education Offices,
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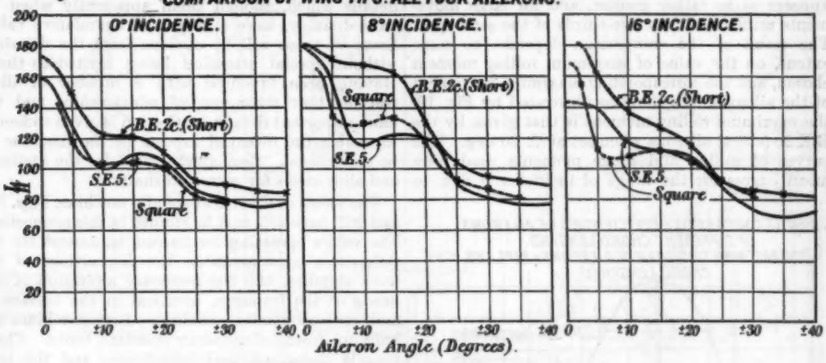
THE DESIGN OF AEROPLANE CONTROL SURFACES WITH SPECIAL REFERENCES TO WING AILERONS.

By H. B. IRVING, B.Sc., A.F.R.Ae.S., of the National Physical Laboratory.

(*Continued from page* 463.)

Comparison of the Efficiences of Control of Ailerons on Wings with Differently-Shaped Tips.—In order that a fair comparison of the efficiencies of different ailerons may be arrived at, it is necessary to compare only ailerons which have the same amount of maximum control. Now, when comparing ailerons of given chord on wings of different plan form, two different ways of obtaining the same maximum control present themselves; either the spans, or areas, of the ailerons may be made the same and the maximum angles through which the ailerons move adjusted by means of the gearing so that the maximum control is the same in each case, or the gearing may be made the same and the spans of the ailerons adjusted so that the maximum control is still the same in each case. It would appear that the latter method of making the comparison for different plan forms of wing tip is preferable to the former. Leaving out, then, the question of gearing, that is, considering the maximum aileron angle to be the same in all cases, the most efficient ailerons are those which have the greatest ratio of rolling moment to hinge moment for a given maximum control. This ratio has been plotted for the various ailerons in Fig. 10. One point of general interest is at once made quite clear from inspection of these figures. It is the large increase in the ratio L/H for all ailerons at small angles below from 5 deg. to 10 deg., and the sharp falling-off at aileron angles above from 15 deg. to 20 deg.

Fig. 10. RATIO OF ROLLING MOMENT (L) TO HINGE MOMENT (H). COMPARISON OF WING TIPS. ALL FOUR AILERONS.



COMPARISON OF AILERONS OF DIFFERENT SPANS. B.E.2c. WING TIPS. ALL FOUR AILERONS.

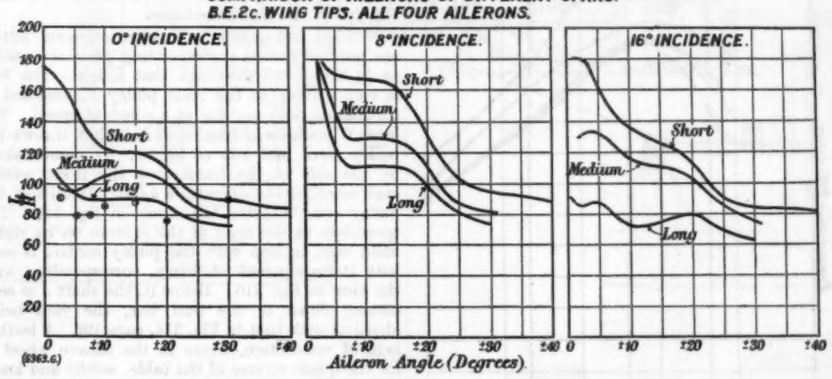


Fig. 11. UPPER WING. 10° INCIDENCE.

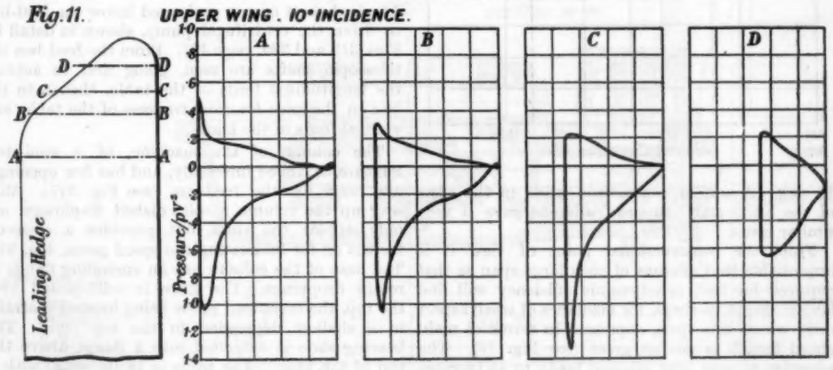
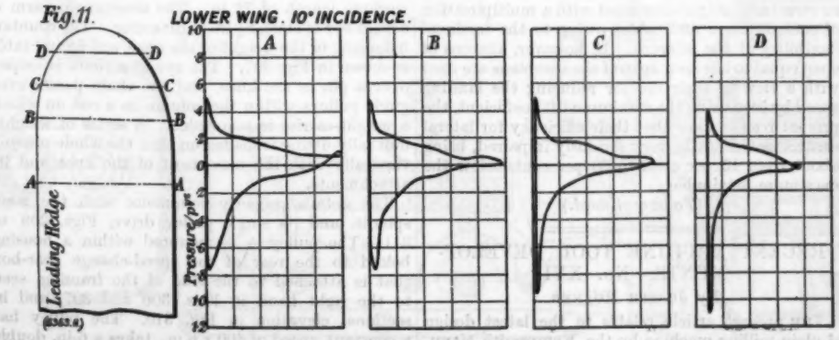


Fig. 11. LOWER WING. 10° INCIDENCE.



Remembering that, for a true comparison of efficiencies of control the amounts of maximum control must be the same, it will be seen that, in order to compare B.E.2c with S.E.5 ailerons, the curves of L/H for S.E. 5 must be compared with curves of L/H for B.E 2c ailerons, which are roughly intermediate between the curves for short and medium spans. The actual curves for the B.E.2c ailerons which would have the same amount of maximum control as S.E.5 ailerons have not been drawn; but since the curves for B.E.2c medium ailerons (which have more maximum control than S.E.5 ailerons) lie above the S.E.5 curves, *à fortiori* B.E.2c ailerons having the same maximum control as S.E.5 ailerons will be more efficient than S.E.5 ailerons. This conclusion bears out what might have been expected from pre-existing data. The R.A.E. found, from full-scale tests (A.C.A., R, and M., No. 532), that the elevators of a tail plane with tips of B.E.2c type, that is, with leading edge longer than trailing edge, were more efficient than the elevators of a tailplane of reverse shape. Such a difference in efficiency might be expected to be less pronounced in the case of an aeroplane wing than in the case of a tailplane, since in the wing with shorter trailing edge, the aileron is less favourably placed for producing rolling moment than in the wing with longer trailing edge.

The results of measurement of the pressure distribution over wings of different plan forms would appear to furnish an explanation of these differences in aileron efficiency. Reference to Fig. 11, which reproduces pressure diagrams taken from A.C.A., R. and M., No. 347, shows that, for the type of wing with long leading edge, the mean pressure on the aileron part of the wing remains roughly constant, or decreases slightly towards the wing tip; for the type of wing with long trailing edge, however, the mean pressure on the aileron part of the wing increases very considerably towards the wing tip. There being no very pronounced movement of the centre of pressure on the aileron portion of the wings, the same may be said of moment about hinge in the two cases as of mean pressure on the aileron. This being the case it would be expected that the rate of increase of hinge moment with aileron angle would be greater for the wing with long trailing edge than for the wing with long leading edge. As regards the efficiency of the "square" ailerons, since, for a given movement they produce about the same rolling moment as the "S.E.5." ailerons, Fig. 10 will give a proper comparison of efficiencies. This figure shows the difference in efficiencies not to be great on the whole.

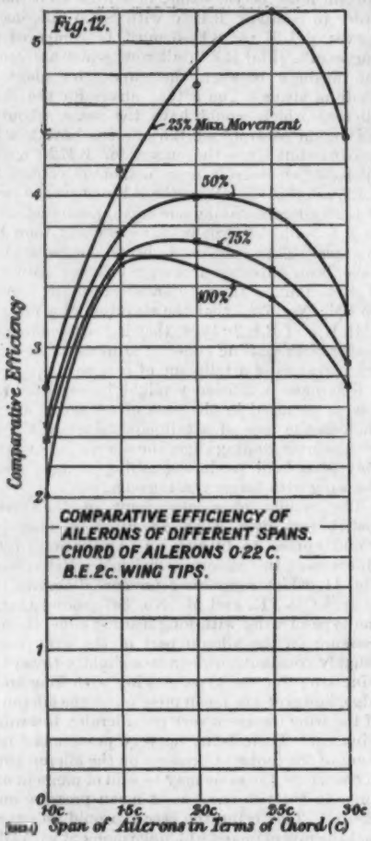
Upper and Lower Ailerons.—It has been mentioned already that no great differences in behaviour of upper and lower ailerons, with respect to rolling and hinge moment, was observed. The same may therefore be said of the ratio of these two and, in this case, also of the efficiency. An examination of all the results, however, shows that there is a slight difference in the efficiencies of upper and lower ailerons, the lower being, on the whole, more efficient than the upper. It is difficult to give any figure for the difference as it varies irregularly with both aileron angle and angle of incidence, but probably does not ever amount to about 10 per cent. at the most and the average difference is probably less than half this figure.

Variation of Efficiency of Control with Span of Aileron; Span for Maximum Efficiency.—In comparing ailerons of the same plan form and chord, but of different spans, the question of the gearing between control column and ailerons must obviously be introduced since the necessary movement of the ailerons to produce a given maximum rolling moment will decrease as the span of the ailerons

increases. This question of gearing and its relation to efficiency of control was first considered by H. Glauert of the R.A.E., in *Advisory Committee for Aeronautics, Reports and Memoranda*, No. 409.

At this stage a general consideration of the manner in which the gearing enters into the question of efficiency of control will not be out of place. Take some given ailerons and gearing, and suppose, for example that, by increasing the size of the ailerons, both rolling moment and hinge moment, are doubled for any given aileron setting. In order that the maximum rolling moments may be the same the gear ratio would (assuming linear variation of rolling moment with aileron angle) require to be doubled in the latter case, and, therefore (assuming

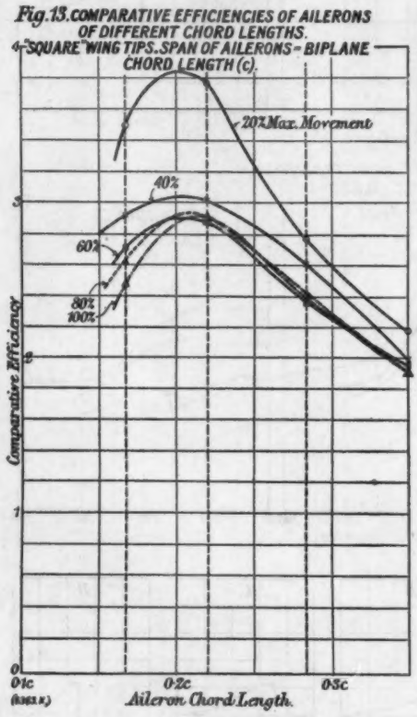
Fig. 12.



also linear variation of hinge moment with aileron angle), any given rolling moment would require only half the effort on the part of the pilot. Thus, although the ratio of rolling moment to hinge moment, for a given aileron setting, is the same in the two cases, the efficiency of the larger ailerons is double that of the smaller ones. It is easily seen that in general, relative efficiencies are obtained by multiplying the ratio L/H for a given aileron setting, by the gear ratio which is appropriate to the given maximum rolling moment. Comparison of efficiencies should then usually be made, not at a given aileron angle, but at angles which are the same fraction of the maximum. An important conclusion at once follows from the above considerations. It is that, roughly speaking, for a given maximum rolling moment, ailerons of given size on both upper and lower wings of a biplane are twice as efficient as ailerons on either upper or lower wing alone. In this connection it is an interesting speculation as to whether, in view of the very common use by the Germans of ailerons on one wing only, this fact was realised by them.

Its bearing on the question as to the variation of aileron efficiency with span points to an increase of efficiency with span up to quite a large span of aileron. This is indeed the case, as is shown by Fig. 12, in which relative efficiency is plotted against aileron span for various percentages of the maximum movement of the ailerons (B.E.2c) and for spans up to the semi-span. In the experiments no measurements were made on ailerons longer than two-thirds of the semi-span, but the performance of ailerons of span longer than this could easily be estimated with fairly reliable accuracy on the assumption that the additional lengths of aileron behaved in a similar manner to the last additional length added in the experiments. The comparison indicates that the best span of aileron is about two-thirds of the semi-span of the biplane; for small movements of the ailerons the best span appears to be rather greater, and for large movements rather less than two-thirds of the semi-span. The result of the comparison depends, to some extent, on the value of maximum rolling moment chosen, and the corresponding maximum movement of the ailerons. In the case illustrated by Fig. 12, the maximum rolling moment is that given by the B.E.2c (short) ailerons when set at ± 20 deg. The curves of rolling and hinge moments used were mean curves for the range of incidence 0 deg. to 16 deg. A similar comparison made in the cases of the S.E.5 and "square" ailerons gave a very similar result.

Fig. 13. COMPARATIVE EFFICIENCIES OF AILERONS OF DIFFERENT CHORD LENGTHS.



From the constructional point of view it is improbable that ailerons of such large span as that required for best aerodynamic efficiency will find favour except, perhaps, for machines of small aspect ratio where this span, expressed in terms of main chord length is not so great (see Fig. 13). The adoption of very long ailerons leads to an increase in structural weight combined with a multiplication of control levers and cables owing to the torsional flexibility of the ailerons. If, however, ailerons of span equal to the semi-span of the aeroplane are used with a view to their use for reducing the landing speed by increasing the maximum lift coefficient, the present results show that their efficiency for lateral control would not be very seriously impaired, being about from 15 per cent. to 20 per cent. below the maximum attainable.

(To be continued.)

RECENT MACHINE TOOL DEVELOPMENTS.—No. XVI.

By Joseph Horner.

The present article relates to the latest design of plain milling machine by the Kempsmith Manufacturing Company, of Milwaukee, for whom the Selson Engineering Company, Limited, of Queen Victoria-street, are the English representatives. It is a remarkable design, evolved by a firm who specialises only in the group to which this machine belongs. It is the result of much development, and experiment continued through several years before the machine was put on the market. The details of speeds and feeds have been worked out in harmony with the most advanced views and stringent requirements of the present day. Many details of value contribute to render the machine an object-lesson in the higher specialisation—details which, though small apparently when regarded singly, have a very high cumulative value. Some of these will be obvious from the drawings without special attention being invited to them. Having been favoured with a number of illustrations that show general relationships and the more important details, a selection is given sufficient to enable the essential aspects of the machine to be understood. Semi-steel is used for the castings, and alloy steels for gears and shafts.

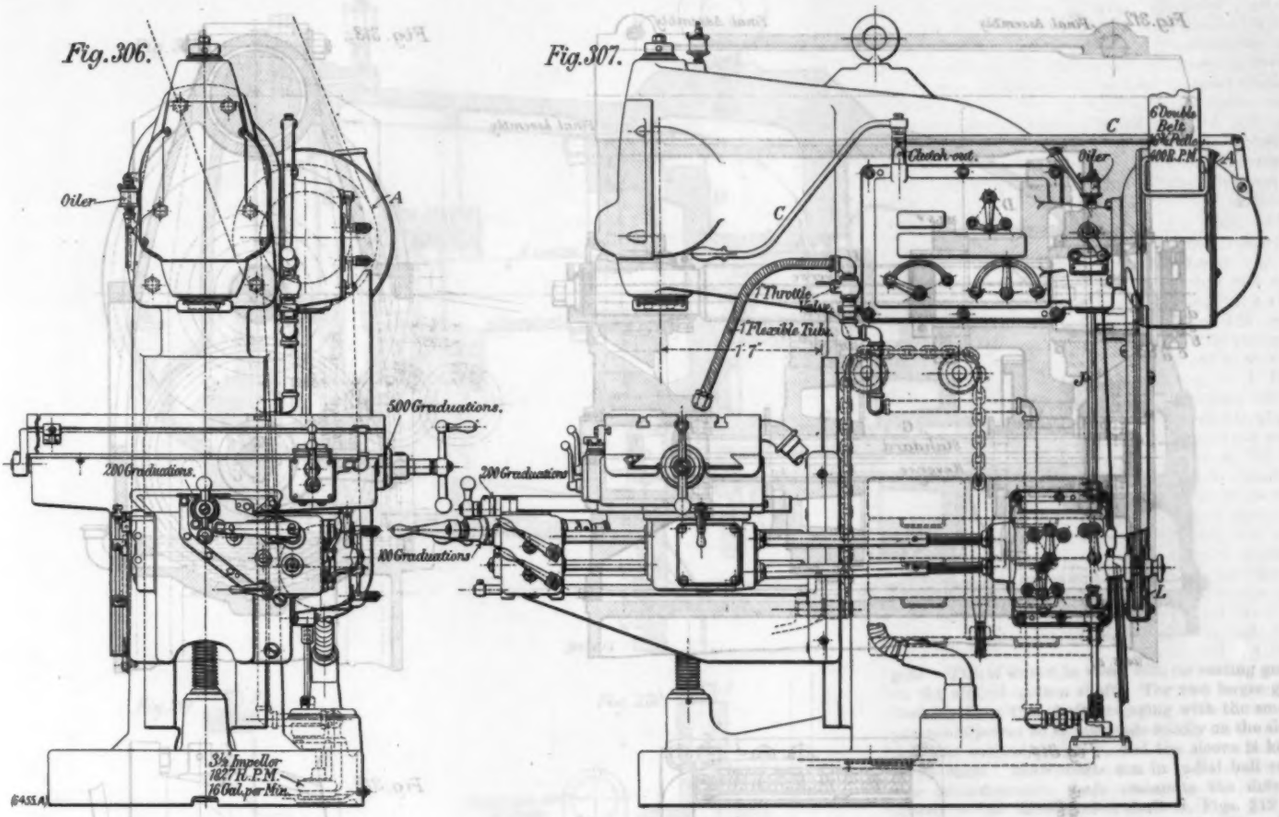
The views of a vertical-spindle machine, Figs. 306 and 307, page 495, may be studied in this connection. The entire operating mechanism is, except for the differences consequent on the dispositions of the work spindles, and the necessary alteration of the heads of the framings, identical in the horizontal and vertical spindle machines. Both machines are built up from independent standard units. These include the speed, and feed boxes, and the feed transmission boxes to the table, saddle and knee, the pump and its connections.

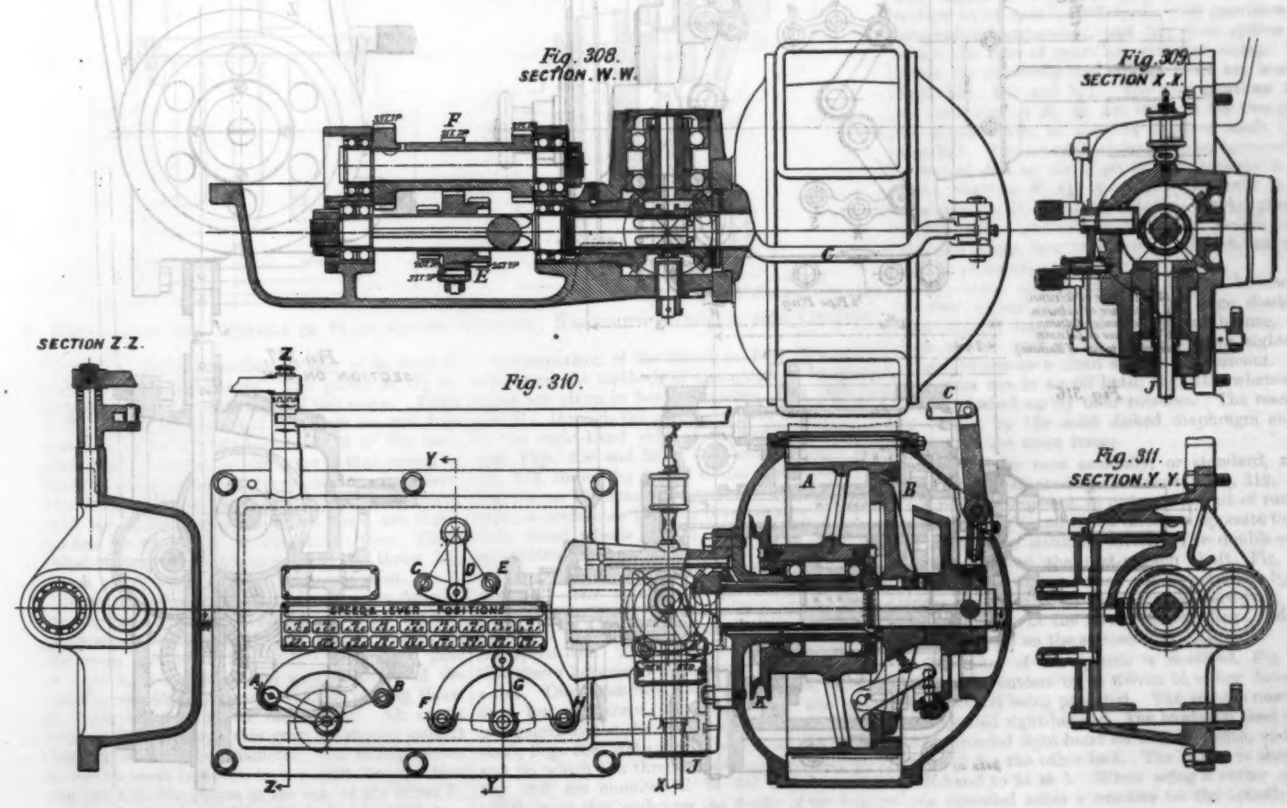
In Figs. 306 and 307 the same reference letters are used, so far as corresponding parts are visible as in the detail drawings that follow. The belt is seen driving to the main pulley A, enclosed in its housing, and running at a constant speed. The lever C operates a friction clutch that throws the pulley into, and out of action. It comes along by the side of the framing to the front, within easy reach of the operator's hand. Details of the pulley and its clutch are shown in Fig. 310. The speed-box at the head of the column on its right-hand side, in line with the pulley centre, is seen with its equipment of levers, corresponding with the view in Fig. 310. Below it, the shaft J is seen coming down to the feed box, the view being identical with that in Fig. 314, page 496. A leather belt, of vee-section, drives to the sheave wheel L, for the quick reverse of the table, saddle and knee. The feed shaft is seen prolonged below the feed-box to drive the centrifugal pump, shown in detail by Figs. 319 and 320, page 497. From the feed-box the telescopic shafts are seen, going first to actuate the longitudinal feeds of the table, thence to the box on the knee for cross-traverse of the table, and vertical feeds of the knee.

The column of the machine, of a semi-steel mixture, is ribbed internally, and has few openings, and none for the feed-box (see Fig. 317). Midway up the column a solid dished diaphragm not only stiffens the sides, but provides a reservoir for the oil for lubricating the speed gears, Fig. 313. The base of the column has an encircling flange to retain droppings. The knee is solid-plated over the top, the cross-feed screw being located centrally in a shallow depression in the top plate. The bearing slide is extended into a flange above the top of the knee. The table is 18 in. wide, with a working length of 72 in. The overhanging arm is a solid bar of steel, 5¼ in. in diameter. The counterbalancing of the weight of the knee, saddle and table is shown in Fig. 307. The eye of a chain is looped over a pin in the knee, and the chain passes over guide pulleys within the column to a rod on which a weight-carrier is suspended. A series of weights mutually fitting is loaded on this, the whole moving vertically with the movement of the knee and its attachments.

The details properly commence with the main spindle, and its single pulley drive, Figs. 308 to 311. The pulley A is mounted within a housing bolted to the rear of the speed-change gear-box that is attached to the side of the framing, seen to the right hand in Figs. 306 and 307, and in sectional elevation in Fig. 310. The pulley has a constant speed of 400 r.p.m., takes a 6-in. double belt, and should be driven by a 15-h.p. motor, which will stand an overload of from 50 per cent.

RECENT MACHINE TOOL DEVELOPMENTS.





FIGS. 306 TO 311. PLAIN-MILLING MACHINE; KEMPSMITH MANUFACTURING COMPANY, MILWAUKEE, U.S.A.

RECENT MACHINE TOOL DEVELOPMENTS.

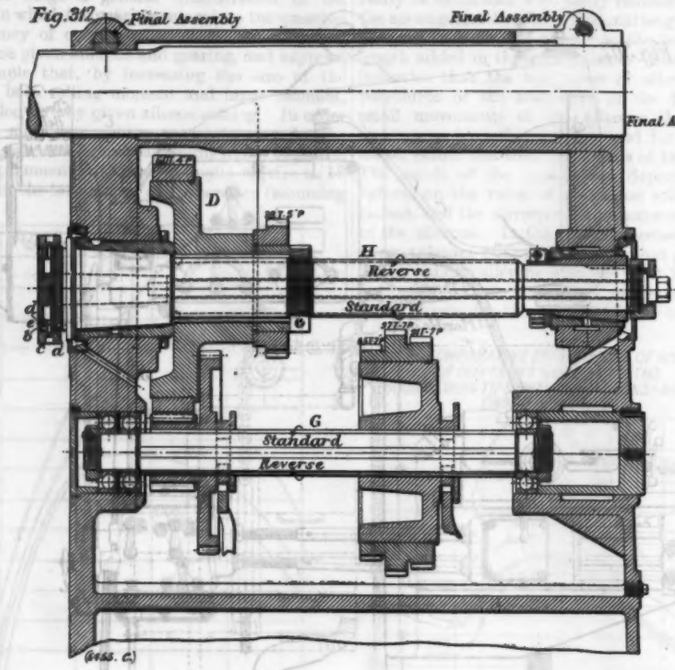


Fig. 312.

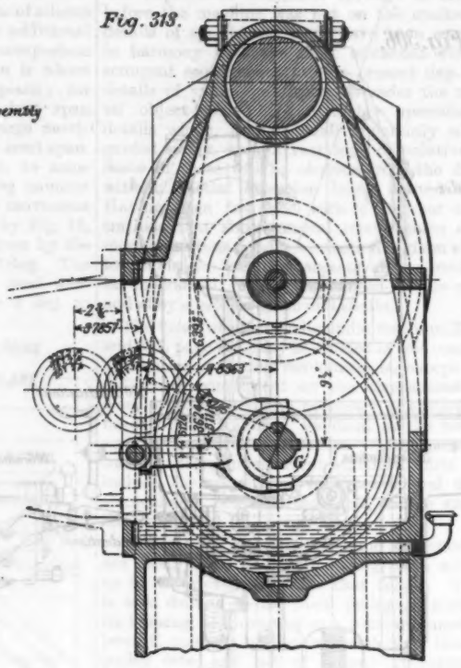


Fig. 313.

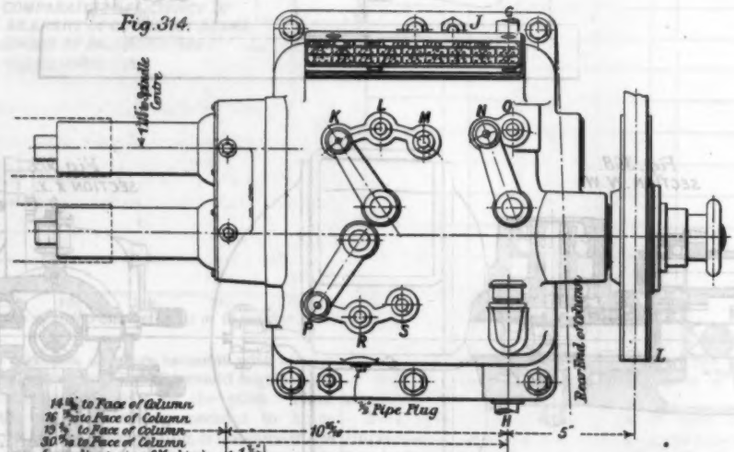


Fig. 314.

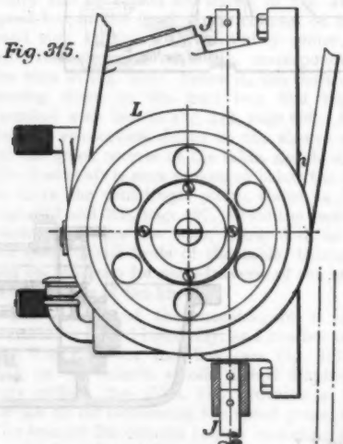


Fig. 315.

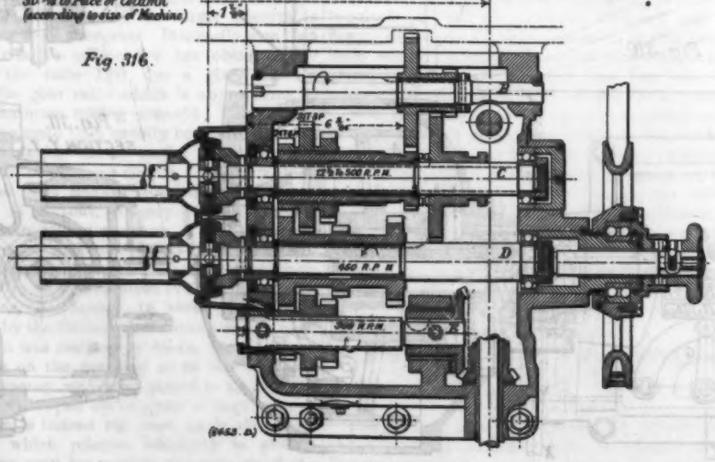


Fig. 316.

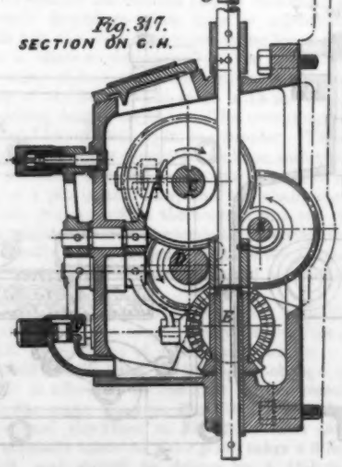
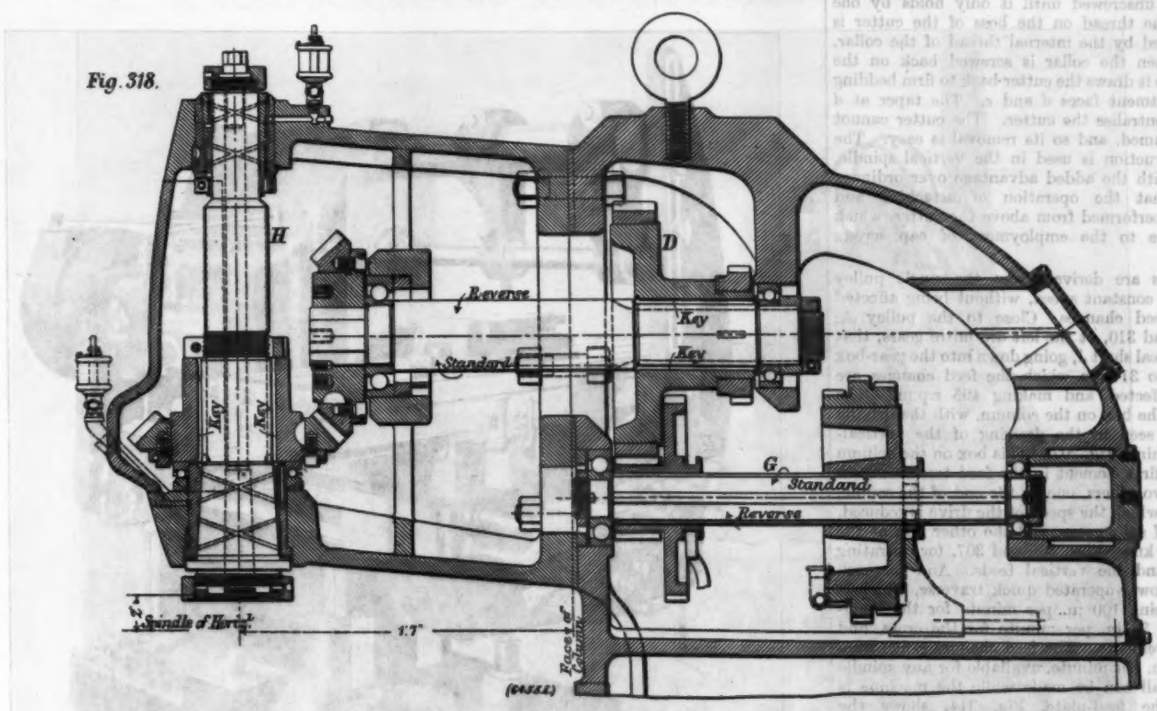
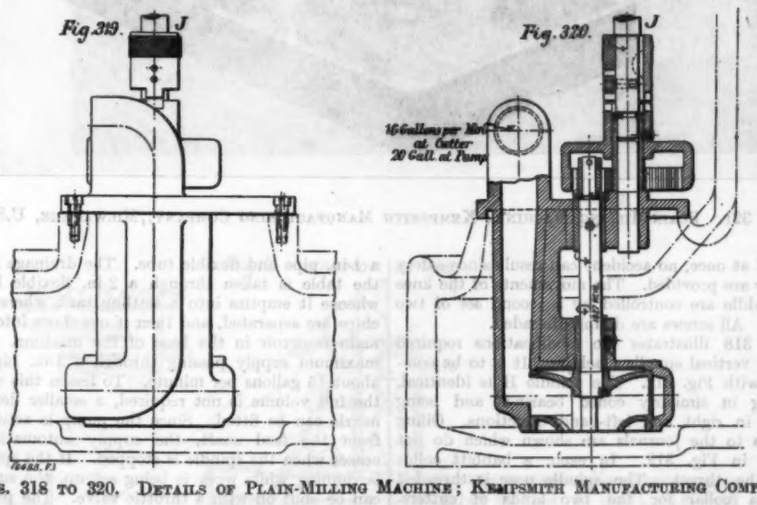


Fig. 317.
SECTION ON C.H.

Figs. 312 to 317. Details of Plain-Milling Machine; Kempsmith Manufacturing Company, Milwaukee, U.S.A.

RECENT MACHINE TOOL DEVELOPMENTS.





FIGS. 318 TO 320. DETAILS OF PLAIN-MILLING MACHINE; KEMPSMITH MANUFACTURING COMPANY.

to 100 per cent., according as the work done is continuous or intermittent. The pulley is 16¼ in. diameter, and runs on two radial ball races. From it the spindle motions and the feeds are put into action through the friction clutch B of the face-plate type, actuated by the lever C that comes to the front of the column within reach of the attendant. The drawing shows the toggle action when closed, with the hooked lever, of which there are three, holding in opposition to the clutch face. Three coiled springs and plungers assist to throw the clutch off at the moment of disengagement.

From the pulley A, 18 speed changes are derived, ranging from 14 r.p.m. to 350 r.p.m. in geometrical progression, terminating at the large wheel D, on the main spindle in Fig. 312. This heavy gear of 4-pitch, is located at the extreme front of the spindle, and slightly hangs over the bearing there, lessening the torsion on the spindle. All heavy work is done through this gear, employing cutters down to about 3 in. diameter. Its sliding pinion is seen in mesh below it, in one with the gear that engages with the pinion in the rear of the wheel D, the two being operated by the forked lever seen.

A comparison of the drawings, Figs. 308 to 312, will reveal the methods of transmission. Sectional views are given in both directions, Figs. 308, 309 and 311, through the speed gear box that is bolted at the right-hand side of the column—compare with Figs. 306 and 307. The end sectional view, Fig. 313, shows the dotted circles that indicate the gear trains. The movable gears are all of the sliding type, in preference to using dive keys, or tumblers. Only those wheels are in actual mesh that are transmitting power, and no more than three pairs are engaged at any time in the transmission elements. The pulley A, Fig. 310, runs loosely on a sleeve that is a prolongation of the domed inner end of the pulley housing, which is bolted to the speed-box. The ball races are assembled on this sleeve between a shoulder, a central bush and a nut. One outer race, that to the right, has freedom for movement endwise. When the pulley is engaged by the clutch B it drives the first motion shaft, Figs. 308, 309 and 311, which has four splines, and on which the three-stepped change pinions E, Fig. 308, are mounted to be slid endwise with a clutch lever that embraces the flanks of the central gear. This is shown in mesh with its mating gear F on the second-motion shaft. The two larger gears flanking F on this shaft, engaging with the smaller pinions adjacent to E, are made solidly on the sleeve with the central pinion F, and the sleeve is keyed to its shaft. Both shafts run in radial ball races. The second-motion shaft transmits the different speeds to the third-motion shaft G, Figs. 312 and 313, thence to the main spindle H. The third-motion shaft runs in ball races, with provision for longitudinal expansion, and has four splines on which the sets of gears are clutched along. The levers for operating the various gears are seen in Figs. 307, 310 and 311. The two positions that are indicated at A, B, are those of the two gears for direct drive, at the left hand of shaft G in Fig. 312. The set of three larger gears mounted on a central disc on the shaft G, are clutched in the three positions F, G, H. The upper lever in the positions C, D, E, moves the three sliding gears E, in Fig. 308. The section Y.Y., Fig. 311, is taken through these last two levers, and shows their spring plungers.

The main spindle H, Fig. 312, is hollow, to receive cutter arbors. It is of large diameter, and runs in long coned bearings of bronze, with take-up for wear. The bearings have sight-feed oilers, to ensure a clean supply of lubricant. But the gears run in an oil bath, Fig. 313, whence the oil is splashed up by their rotation. The reservoir is formed by the solid dished diaphragm shown, cast with the main frame.

The spindle runs normally, or standard, right-handed, as indicated by the arrow in Fig. 312. But a reverse is provided, in order to permit of running a face milling cutter in the direction opposite to that of a spiral or slabbing cutter. The double-ended clutch seen on the first-motion shaft, Fig. 308, provides for this reversal. It is actuated by the lever to the extreme right of the speed-box, Figs. 307 and 310, in the two positions Rev., Std. It is also shown on the section X.X., Fig. 309.

The nose of the spindle is modified, Fig. 312, to receive cutters to be driven in either direction, the method being patented. The spindle nose at *a* is threaded right-handed. The hardened steel collar *c* is threaded right-hand for half its width, and left-handed for the other half. The cutter is threaded left-hand to fit at *b*. When using a cutter arbor, the threaded collar *c* remains on the spindle nose

serving the purpose of a guard. When a face-milling cutter is to be attached to the spindle, the collar *c* is unscrewed until it only holds by one thread. The thread on the boss of the cutter is then engaged by the internal thread of the collar, so that when the collar is screwed back on the spindle nose it draws the cutter back to firm bedding on the abutment faces *d* and *e*. The taper at *d* serves to centralise the cutter. The cutter cannot become jammed, and so its removal is easy. The same construction is used in the vertical spindle, Fig. 318, with the added advantage over ordinary methods that the operation of attaching and removal is performed from above the cutter, which is preferable to the employment of cap screws beneath.

The feeds are derived from the single pulley drive at its constant speed, without being affected by any speed changes. Close to the pulley A, Figs. 308 and 310, at the left are mitre gears, that drive a vertical shaft J, going down into the gear-box (Figs. 314 to 317) in which the feed changes are primarily effected, and making 495 r.p.m. The position of the box on the column, with the driving shaft J, is seen in the drawing of the vertical-spindle machine, Fig. 307. This box on the column is only the first element in the feed transmissions. There are two others, one on the end of the saddle, Fig. 307, in which the speed of the drive is reduced, by means of spur gears, and the other box at the front of the knee, Figs. 306 and 307, for operating the cross, and the vertical feeds. And for each there is a power-operated quick traverse, which is constant, being 100 in. per minute for the longitudinal and 38 in. per minute for the cross, and vertical movements. The feed changes range from $\frac{5}{8}$ in. to 25 in. per minute, available for any spindle speed, and all can be made while the machine is running. The feed-plate, Fig. 314, shows the various lever movements and combinations for the various feeds. The quick-return traverse is imparted from the sheave wheel K, Fig. 310, alongside the pulley, and running with it. This drives, by a leather belt, of vee section, to a similar sheave L, Figs. 314 to 316, outside the feed gear-box, whence the quick return traverses are imparted by the clutching of the knob on the end of the shaft with the boss of the loosely-running sheave L. The views of the feed-box on the column, Figs. 314 to 317, comprise the external appearance, showing the levers, the end view of the sheave pulley, the conventional, developed lay-out of shafts and gears, as though in one plane, Fig. 316, and the end section, Fig. 317—the section on G—H of Fig. 314, in which the actual relations are illustrated. The vertical shaft, driven by the mitre gears in Figs. 308 and 310 is seen at J. Shaft J at 495 r.p.m. drives through the bevel gears seen in Figs. 316 and 317, the shaft E, constantly at 300 r.p.m. Three sliding gears on this, Fig. 316, moved by the lower lever on the box, in positions P, R, S, Fig. 314, drive through intermediate gears on shaft D to the feeding shaft C connected with the telescopic shaft. Gears on shaft B can be clutched with mating gears on C at the right, Fig. 36. These are meshed by the lever in positions N, O, Fig. 314. The lever adjacent, positioned at K, L, M, actuates the three sliding gears of shaft C, the lever positioned at P, R, S, moves the three gears on shaft E. From the combinations obtained, the feed changes stated on the plate result. The sheave wheel L when clutched drives the shaft D, for quick return at 450 r.p.m. These drives and reverse are, as stated, available for the longitudinal movements of the table, and for cross and vertical feeds. The shaft C, Fig. 316, makes from 12½ r.p.m. to 500 r.p.m., the latter corresponding with the 25-in. feed, a marvellous rate by comparison with those of the machines of a few years since. The movements of the table, saddle and knee can be operated by hand, by levers seen in Figs. 306 and 307. The dials read in thousandths of an inch. For one turn of a lever the movement of the table is 0·50 in., that for the cross feed is 0·20 in., and that for the vertical feed is 0·10 in. The control of the table movements is by two levers, one for the feed, the other for the power quick traverse. A lever is simply pushed in the direction in which the table is required to move. If both should be pushed at once, no accident can result since safety devices are provided. The movements of the knee and saddle are controlled by a second set of two levers. All screws are double-threaded.

Fig. 318 illustrates the modifications required for the vertical spindle machine. It is to be compared with Fig. 312. The spindle H is identical, running in similarly coned bearings and being driven in right and left-hand directions. Oiling grooves to the journals are shown which do not appear in Fig. 312. In each, a babbitt collar takes the thrust. The spindle nose is threaded with a collar for the two kinds of cutters. The splined shaft G, with its sliding gears, is seen to be alike in both machines, and also the heavy driving gear D. This in the vertical spindle machine is carried on a separate shaft instead of on the spindle, whence the drive to the latter goes through helical mitre gears, keyed and screwed to intermediate bosses, the gears being of an alloy steel. A bracket is bolted to the face of the column to carry the additional elements. Ball bearings are used. The thrust bearing for the vertical spindle is of the swivel design. Those for the transmitting spindles are radial, except the front race that carries the shaft for the first mitre gear, which combines provision for radial and thrust pressures. In the fitting of the sliding races, longitudinal expansions are allowed for.

The vertical shaft that is the first element in the transmission of the feeds is prolonged below the feed-box to drive the centrifugal pump, compare Fig. 307 with Figs. 319 and 320—for cooling the cutters. It is driven through a clutch, to be disengaged if a cooling fluid should not be required. The pump is submerged in the reservoir within the column. The fluid is conveyed through a 1-in. pipe and flexible tube. The drainage from the table is taken through a 2-in. flexible hose, whence it empties into a settling tank where fine chips are separated, and then it overflows into the main reservoir in the base of the machine. The maximum supply passing through a 1-in. pipe is about 15 gallons per minute. To lessen this when the full volume is not required, a smaller flexible nozzle can be fitted. Since the pump is actuated from the feed shaft, the supply automatically ceases when the spindle is stopped. If the spindle is running while work is being set up, the supply can be shut off with a throttle valve. The photograph, reproduced in Fig. 321, illustrates the external appearance of the machine.

RECENT MACHINE TOOL DEVELOPMENTS.

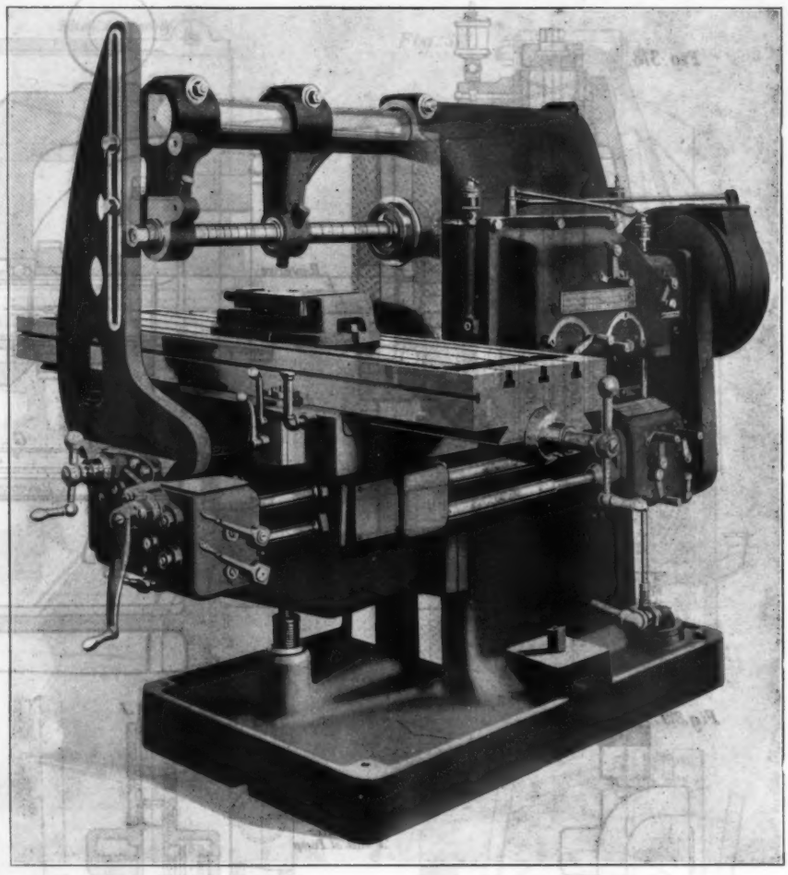


Fig. 321. Plain-Milling Machine; Kempsmith Manufacturing Company, Milwaukee, U.S.A.

FERRO-CONCRETE PIT-HEAD FRAME AT BENTLEY COLLIERY, DONCASTER.

An interesting example of ferro-concrete work is illustrated on pages 499 and 500, and in our two-page Plate accompanying this week's issue of Engineering. It consists of a pit-head frame and heapstead, at Bentley Colliery, Doncaster. Before the proprietors of this colliery adopted the method of construction illustrated, for their No. 2 pit, they had already had experience with a ferro-concrete structure at their No. 1 pit, the heapstead there, comprising the whole building from foundations to roof, including platforms, gangways, &c., having been erected on the Hennebique principle. The pit-head frame, however, in that case was of structural steel, supported by the ferro-concrete building. In the installation now dealt with, as our illustrations show, the pit-head frame, including the tower and back stays, is of reinforced concrete.

The main features of this structure may be gathered from Figs. 1, 2 and 3, on page 499, the first of these being a general view of the structure, the second a sectional elevation and the last a plan of the foundations.

The main building is about 132 ft. long by 32 ft.

FERRO-CONCRETE PITHEAD FRAME AT BENTLEY COLLIERY, DONCASTER.

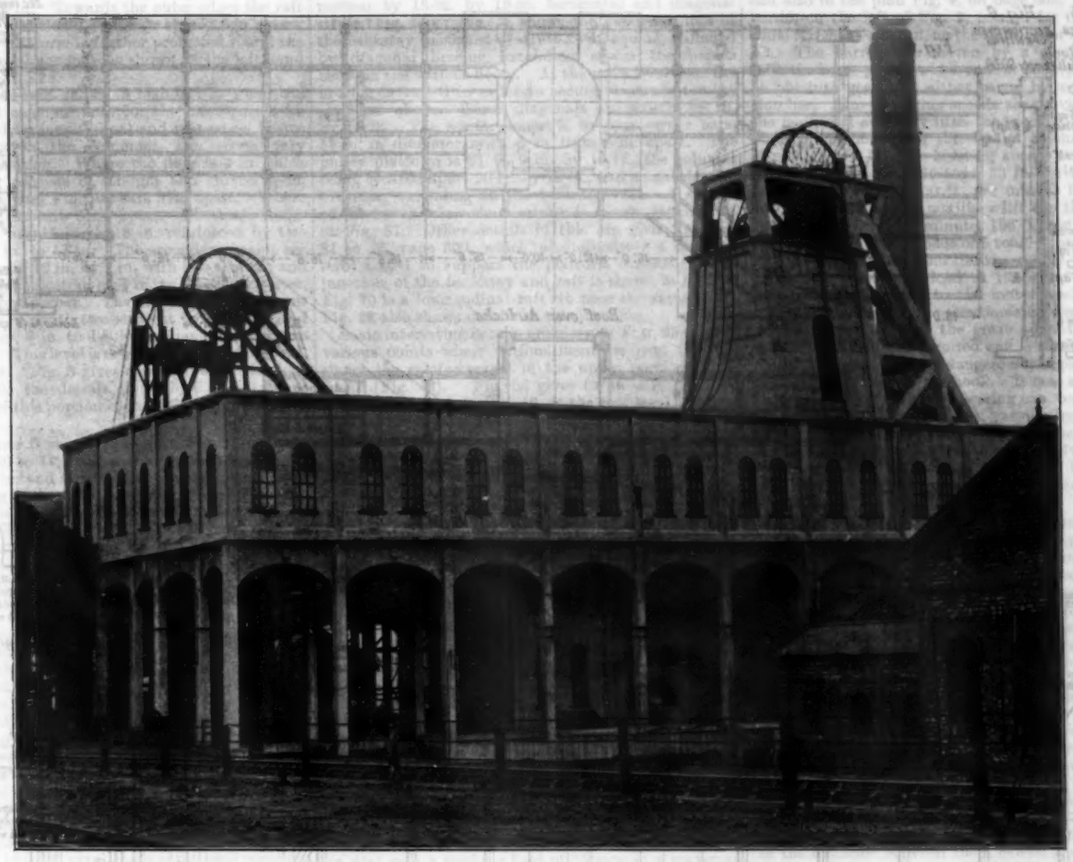
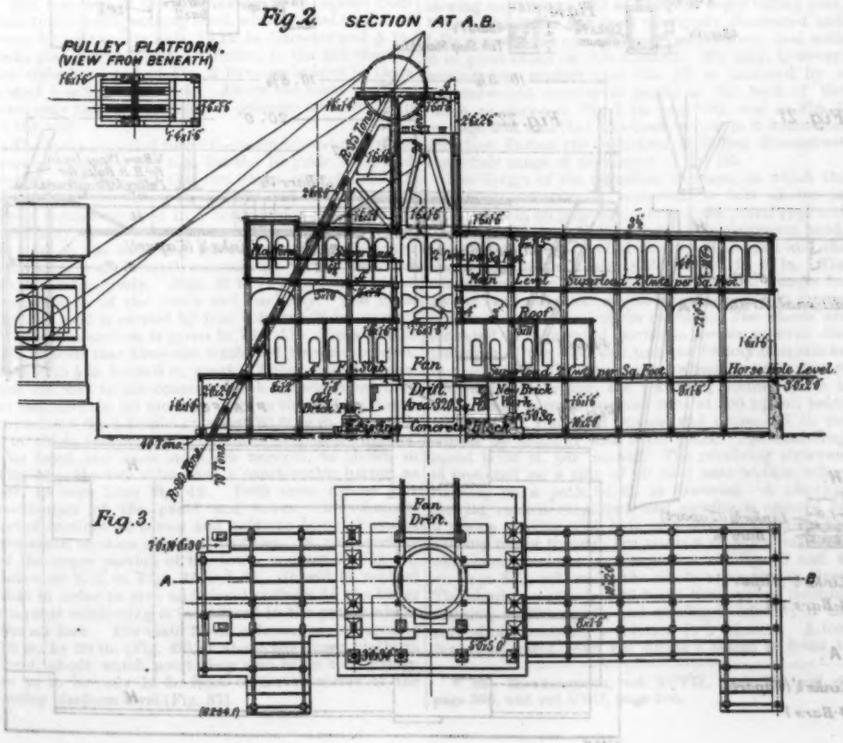


Fig. 1.

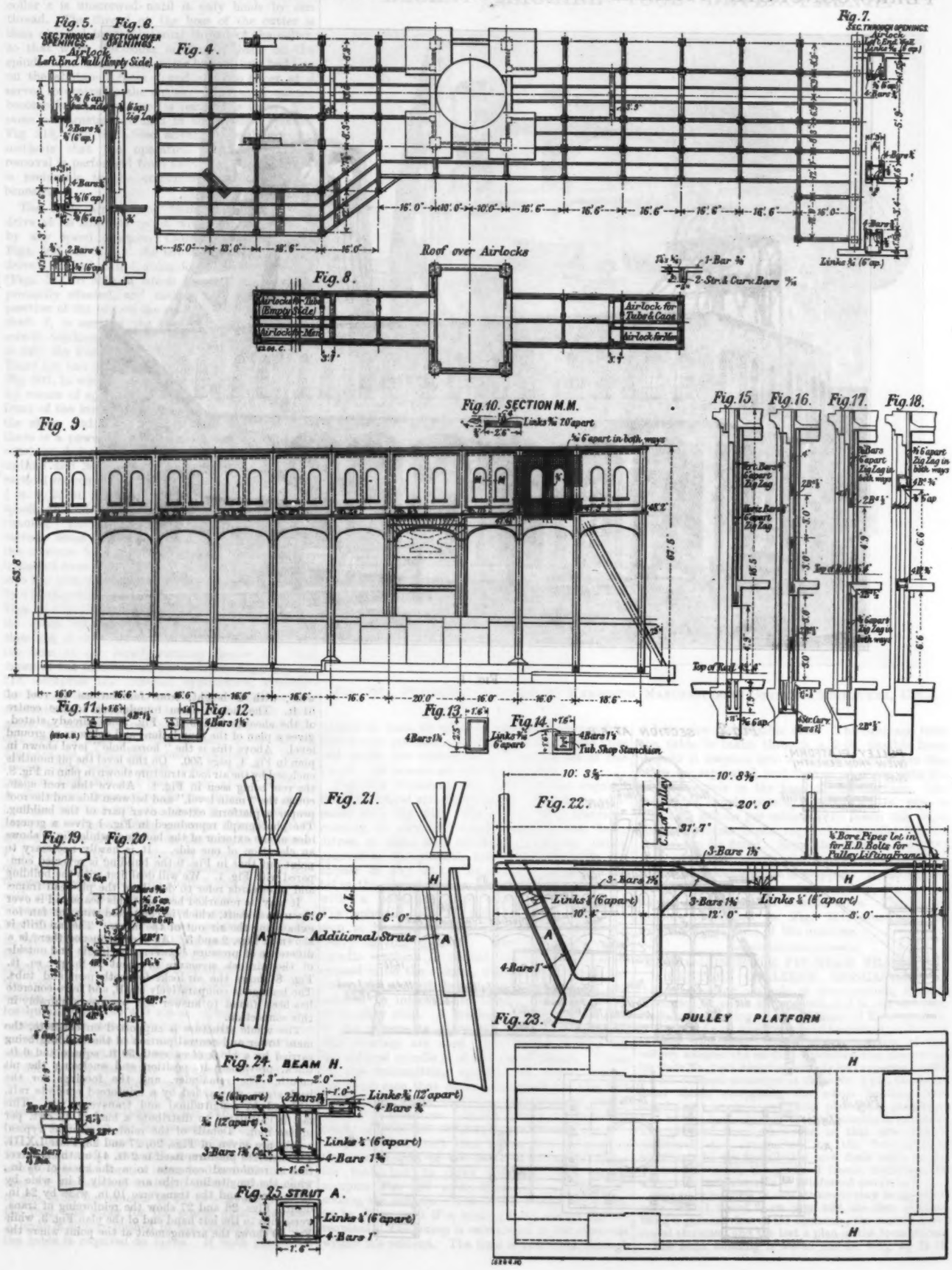


wide, with a height, from foundations to roof of 64 ft. The height from foundations to the centre of the sheaves is 109 ft. Fig. 3, as already stated, gives a plan of the foundations and columns at ground level. Above this is the "horse-hole" level shown in plan in Fig. 4, page 500. On this level the pit mouth is enclosed by the air lock structure shown in plan in Fig. 8, the roof being seen in Fig. 1. Above this roof again comes the "main level," and between this and the roof proper a platform extends over part of the building. The photograph reproduced in Fig. 1 gives a general idea of the exterior of the building, while Fig. 9 shows an elevation of one side. It is hardly necessary to point out that in Fig. 9 the building is reversed compared with Fig. 1. We will deal first with the building and afterwards refer to details of the pit-head frame.

It may be remarked here that this headstead is over the upcast shaft, which is connected with the fan for exhausting the air out of the mine. The fan drift is shown in Figs. 2 and 3. As a consequence there is a difference of pressure between the inside and outside of the air-lock structure of about 20 lb. per sq. ft. Fig. 8 shows the air-locks for both men and tubs. The leakage is comparatively small, and ferro-concrete has been found to answer the purpose admirably in this connection.

The whole structure is supported on concrete, the main tower and central portion of the building being carried by a block of concrete 50 ft. square and 6 ft. thick, previously in position and enclosing the pit mouth. The remainder, and the footings for the back stays, are carried by a reinforced concrete raft, stiffened by longitudinal and transverse ribs. This raft is calculated to distribute a load of 15 cwt. per square foot. Details of the reinforcement at typical points are given in Figs. 26, 27 and 28, Plate LXIII. The concrete platform itself is 2 ft. 4½ in. thick; over this is reinforced concrete to a thickness of 5½ in., while the longitudinal ribs are mostly 8 in. wide by 18 in. deep, and the transverse 10 in. wide by 24 in. deep. Figs. 26 and 27 show the reinforcing of transverse ribs to the left hand end of the plan Fig. 3, while Fig. 29 shows the arrangement at the point where the

FERRO-CONCRETE PITHEAD FRAME AT BENTLEY COLLIERY, DONCASTER.



back stay joins the raft, the diagonal part shown being a portion of a diagonal strut extending between the two main backstay members. The straight and curved reinforcing bars vary from ½ in. to 1¼ in. In a few cases 1½ in. bars are used. The stirrups are 1¼ in. by either ⅞ in. or ½ in. Towards the outer edges the raft is reinforced by additional ½-in. bars spaced 6 in. apart, while the main platform is further protected round the sides by reinforced concrete as shown at the left-hand end of Figs. 26 and 28.

The horse-hole level shown in plan in Fig. 4 consists of a reinforced concrete floor for the most part 4 in. thick supported by longitudinal and transverse beams extending between the columns. The spans vary according to position. Where the floor is 4 in. thick the reinforcing consists of straight and curved ⅜-in. bars 6 in. apart, and ½ in. top bars 8 in. apart. Where 3 in. thick all bars are 8 in. apart. The main longitudinal beams are 15 in. by 8 in. reinforced by two bottom bars ⅞ in. to 1½ in. The secondary beams are 12 in. by 5 in. and 12 in. by 7 in. with two straight and curved bars at the bottom of ⅞ in. to 1⅛ in. diameter, and a single ½ in. top bar. The main transverse beams are 14 in. by 8 in., with two straight bottom bars and two curved bars, ⅞ in. to 1⅛ in. in diameter, and two ½-in. top bars. This level is designed for a load of 2 cwt. per square foot. Fig. 8 gives a section of the air lock structure, while the details, Figs. 5, 6 and 7, show various parts of this portion of the building as end wall, columns, &c.

The main floor is shown in plan in Fig. 29, and the details, Figs. 30 to 41, show several typical beams, &c. This floor is 4 in. and 5 in. thick. In the former parts the reinforcing is by ½-in. and ⅜-in. bars 5 in. and 6 in. apart; in the latter by bars ⅜ in. and ⅞ in. in diameter, spaced 5½ in. apart. These figures refer to the straight and curved bars, the top bars in all cases being ½ in., spaced 10 in. apart. Fig. 39 gives a section at the point Z Z indicated on Fig. 29, and needs no further explanation. The outer rows of beams for this floor take the form of reinforced arches as shown in Fig. 9. At the point Y Y a well is arranged in the floor to take the foot of the retarder gear. The reinforcement of this section is shown in Figs. 32 and 36. Above this floor is a platform extending to the end of the building on the "empty" side of the shaft, but for a length of only 18 ft. on the other side, as shown in Fig. 2. This platform is of reinforced concrete, 6½ in. thick, and is designed for a load of 2 cwt. per square foot. The roof above is 3½ in., carried by main and secondary beams respectively 8 in. by 17 in. and 5 in. by 9 in. Except for the air locks, only the top floor is enclosed by side and end walls. A typical piece of reinforcing for the wall panels is shown in Figs. 9 and 10. The sections, Figs. 15 to 20, give details of this wall panelling. The vertical and horizontal bars are ⅜ in. and ⅛ in., spaced 6 in. apart both ways. The panels are 4 in. thick. The arch beam reinforcement is by 1-in. bars and 1½-in. by ½-in. stirrups.

The majority of the columns are 18 in. square from floor to the main banking level, with vertical reinforcement by four corner rods, 1½ in. in diameter and ⅜ in. links placed 6 in. apart. Columns in the tub shop at the right-hand end of Fig. 2 have embedded in them a steel I-section stanchion. Above the main banking level only the exterior rows of columns are carried up to the roof.

The loads provided for in the main tower and frame were as follows: 115 tons for the 10 guide ropes and weights, 40 tons for the two cages and chains, six empty and six full tubs, pulleys and winding rope. These figures resulted in a compression stress on the back stay of 35 tons due to the gear and of about 80 tons on the back stay footing, which resolved into horizontal and vertical components of 40 tons and 70 tons respectively. Figs. 42 to 71 give details of the construction of the tower and backstay. The main vertical load is carried by four columns 36 in. square, of which a section is given in Fig. 51. From this it will be seen that these are reinforced by sixteen 1½-in. bars with ½ in. loops 6 in. apart. These columns transmit the load to the concrete block already referred to as enclosing the pit mouth. Above the roof the tower is enclosed for a height of about 30 ft. 8 in. by panels 5 in. thick, pierced on the two sides by glazed windows. The front and back sides are vertical, as shown in Fig. 43; the two sides have a considerable batter, as will be seen from Fig. 42. Both these figures give particulars of the panel and tower reinforcement, detail sections of beams and columns being shown in the small sections attached to them. A cross-section of the upper portion of the tower is given in Fig. 54, taken at X X in Figs. 42 and 43. It will be noticed that in order to give additional stiffness to the tower diagonal reinforcing is introduced in the panels above the air lock. The main 36-in. columns are reduced to 30 in. by 30 in. (Fig. 42) at about the upper platform level, about which point they also begin to converge so as to be only 12 ft. from corner to corner at the pulley platform level (Fig. 57).

The backstay construction is illustrated in Figs. 58, 59, &c. Fig. 58 is a drawing of the backstay proper, while Fig. 59 shows the vertical and other bracing provided for it. It is supported by three pairs of 18 in. by 29 in. columns, and is braced to the tower portion by 18-in. by 18-in. horizontal and diagonal struts (Fig. 59). Fig. 58 shows the two main legs of the backstay to consist of struts 24 in. square, stiffened by diagonal bracing extending across the panels between the various floors. At the main level floor the bracing is varied in order to secure clearance for the platform above. These diagonals are mostly 18 in. by 18 in. The reinforcement is by four corner bars, 1½ in. in diameter, with ⅜-in. links 6 in. apart. The pulley platform is 31 ft. 9 in. by 16 ft., the columns being centred apart 20 ft. by 12 ft., and a considerable overhang extending on the backstay side. A section of the tower below the platform is shown, looking up, in Fig. 57. Other details of this are given in Figs. 21 to 25, page 500, which also illustrate a diagonal strut added to support the platform overhang. The junction of the backstay and raft is shown in Fig. 71. Fig. 70 is a longitudinal raft rib near the same point. Fig. 28 also shows details at this junction.

Some interesting details are given in Figs. 65 to 69 of various points where various members join. Fig. 65 shows the reinforcement of the upper portion of the tower (Fig. 42). Fig. 66 gives to an enlarged scale other details seen in Fig. 42, at the roof level, showing vertical secondary 24-in. by 24-in. columns and the main 30-in. by 30-in. columns battered. Fig. 67 shows the junction of the tower, roof and diagonal struts for the backstay at Z, Fig. 59. Figs. 68 and 69 are details of the backstay, the latter being at X in Fig. 58, where diagonals and horizontal braces join the main member, and the former at the main floor level at Y, Fig. 58.

The work was carried out by the Yorkshire Hennebique Contracting Company, Kirkstall-road, Leeds, to the designs of Messrs. L. G. Mouchel and Partners, Limited, 36 to 38, Victoria-street, Westminster, to whom, with Messrs. Barker, Walker and Co., the proprietors of the Bentley Colliery, we are indebted for the information contained in this article.

25-TON ELECTRIC LUFFING CRANE.

The photographs reproduced on page 502 and the line drawings on page 503 of this issue, illustrate a 25-ton electric crane fitted with Toplis horizontal luffing gear and balanced jib, two of which have recently been supplied to the Port of London Authority by Messrs. Stothert and Pitt, Limited, Bath. One of these cranes is now in use at the Royal Albert Docks and the other at Tilbury Dry Docks. Each is designed to deal with a working load of 25 tons at a maximum radius of 83 ft. and a minimum radius of 35 ft., but auxiliary hoisting gear is fitted to lift loads up to 5 tons at radii 4 ft. greater than those above-mentioned. The cranes are fitted with the usual travelling and slewing motions, as well as with the Toplis luffing gear, but as the latter has been previously illustrated and fully described in our columns* we need not deal with it in great detail on this occasion. We may, however, remind our readers that the jib is balanced by a counterweight moving in guides at the back of the crane, as shown in Fig. 1 on page 502, and in Fig. 3 on page 503, and that the load moves in a horizontal direction during the operation of luffing throughout the whole range of movement of the jib.

The design of the travelling carriage, on which the revolving structure is mounted, is best shown in Figs. 3 and 5, on page 503. It is of the portal type and runs on a track of 25-ft. gauge. The maximum headroom between the level of the top of the rail and the lower side of the main girders is 17 ft. 2 in. The carriage runs on 16 wheels having central flanges for use on twin rails, the wheels being arranged in groups of four at each corner of the carriage. The wheels are mounted in compound bogies to secure an even distribution of the load and to allow for any inequalities in the track. The two central wheels in each set are geared for travelling, the travelling motor, which is of 40 brake horse-power and runs at 550 r.p.m., being mounted on the main girders and connected to the wheels by shafting and bevel gears. The travelling speed is 50 ft. per minute. The revolving structure is mounted on a ring of 40 steel anti-friction rollers running on a path 25 ft. in diameter. A pin-type slewing rack is employed, and slewing is effected by a pinion gearing with this rack and operated by the slewing motor through the medium of worm and spur reduction gearing; an inspection of Figs. 3 and 4, on page 503, will make the whole arrangement clear. The slewing motor is a 25 brake horse-power machine running at 600 r.p.m., and slewing is effected at the rate of one complete revolution in 2 minutes. A foot brake, operated from the driver's cabin, is fitted to enable the revolving structure to be brought to rest in any required position.

The two lifting barrels with which the crane is provided are shown in Fig. 2, which is reproduced from a photograph of the interior of the machinery cabin, and also in the plan Fig. 4, on page 503. The longer barrel, on the left of Fig. 2, is used for the main lift while the shorter barrel, on the right, is for the auxiliary lift. The barrels are driven by a single motor of 50 brake horse-power, which runs at 550 r.p.m., and can be put into gear with either barrel by means of claw clutches. Three hoisting speeds are provided for both the main and auxiliary lifts, the speed variation being obtained by means of three pairs of change wheels. For the main lift the hoisting speeds are 20 ft. per minute for a load of 25 tons, 33 ft. per minute for a load of 15 tons, and 50 ft. per minute for a load of 10 tons, while for the auxiliary lift the three hoisting speeds are 100 ft. per minute, 166 ft. per minute, and 250 ft. per minute for loads of 5 tons, 3 tons and 2 tons, respectively. A solenoid brake, visible in Fig. 2, is provided to hold the load in the event of a failure of the current supply to the motor, and lowering is effected by means of potentiometer braking. This method of braking has the great advantage that the motor is never open-circuited and is therefore never in danger of being run at a dangerously high speed by the weight of the load on the hook. It is so arranged that a predetermined speed of lowering can be obtained on each of the controller notches, varying from a creeping speed to any reasonably high speed. The arrangement is extremely simple to operate as it involves no extra foot pedals or hand levers, the control being entirely governed by the manipulation of the hoist controller handle.

The motor partly visible on the extreme right of Fig. 2, is a 25 brake horse-power 600 r.p.m. machine, which drives the luffing barrel through single-reduction worm gearing. This gearing, and that used for the slewing motion, are both completely enclosed in oiltight casings. Luffing, in this particular crane, is effected at the rate of 70 ft. per minute, and an interesting feature of the mechanism is the arrangement which enables the horizontal movement to be obtained for loads on both the main and auxiliary hooks, although these are at different distances from the centre of the crane. For this purpose the auxiliary hoist rope is led from its barrel over a pulley mounted on a framework attached to the front of the revolving structure, then to a pulley on the back of the jib near its upper end, and back to a second pulley on the revolving structure, and finally over the jib-head pulley and down to the load. The positions of the pulleys are so chosen that, when the jib is luffed in, the shortening of the distance between them causes a portion of the auxiliary hoisting rope to be paid out exactly equal in length to the distance which the centre of the pulley at the end of the jib rises. For this reason the load on the auxiliary hoist hook travels inwards along a horizontal line. The arrangement of the main hoisting rope is as follows: The rope is led from the hoisting barrel over pulleys on the revolving structure and jib-head to the snatch block, back to the jib-head and snatch block again (so that the load is carried on four parts of the rope), back along the jib to another pulley on the revolving structure, and finally on to the central enlarged portion of the luffing barrel shown in the plan Fig. 4, on page 503. The hoisting rope is wound round the luffing barrel in the opposite direction to the luffing ropes, so that the former is paid out as the latter are wound in, and the ratio of the diameters of the two portions of the barrel is such that the amount of rope paid out is just sufficient to compensate for the rise of the main hoist pulleys at the end of the jib. Thus the main load also moves in horizontally during the operation of luffing, and it will have been noticed that, in both cases, the result is achieved in a simple and direct manner without employing any complicated mechanical contrivance. The moving counterweight at the back of the crane, which, as above-mentioned, is provided to balance the jib, is composed of a number of cast-iron slabs suspended on two steel wire ropes. These ropes are taken over pulleys and wound on the luffing barrel so that when the jib is luffed out the balance weight is raised. The two principal advantages claimed for the arrangements above described, which are the subjects of the Toplis patents, are that luffing can be carried out at a high speed with the expenditure of but little power, and that there is no tendency for the jib to "take charge" with either a light or a heavy load. It has also the additional advantages of being safer and more convenient for the driver than the ordinary method of luffing.

In both of the cranes we are describing the whole of the machinery on the revolving structure is protected by a timber house, and the driver's cabin, which is partitioned off from the machinery house, extends forward from the latter, as is best shown in Fig. 1. In this position the driver has a good view of the load and of his surroundings. A circular plat-

* See Engineering, vol. XCVII, page 874, vol. C, page 306, and vol. CVII, page 208.

25-TON ELECTRIC CRANE WITH TOPLIS LUFFING GEAR.

CONSTRUCTED BY MESSRS. STOTHERT AND PITT, LIMITED, ENGINEERS, BATH.

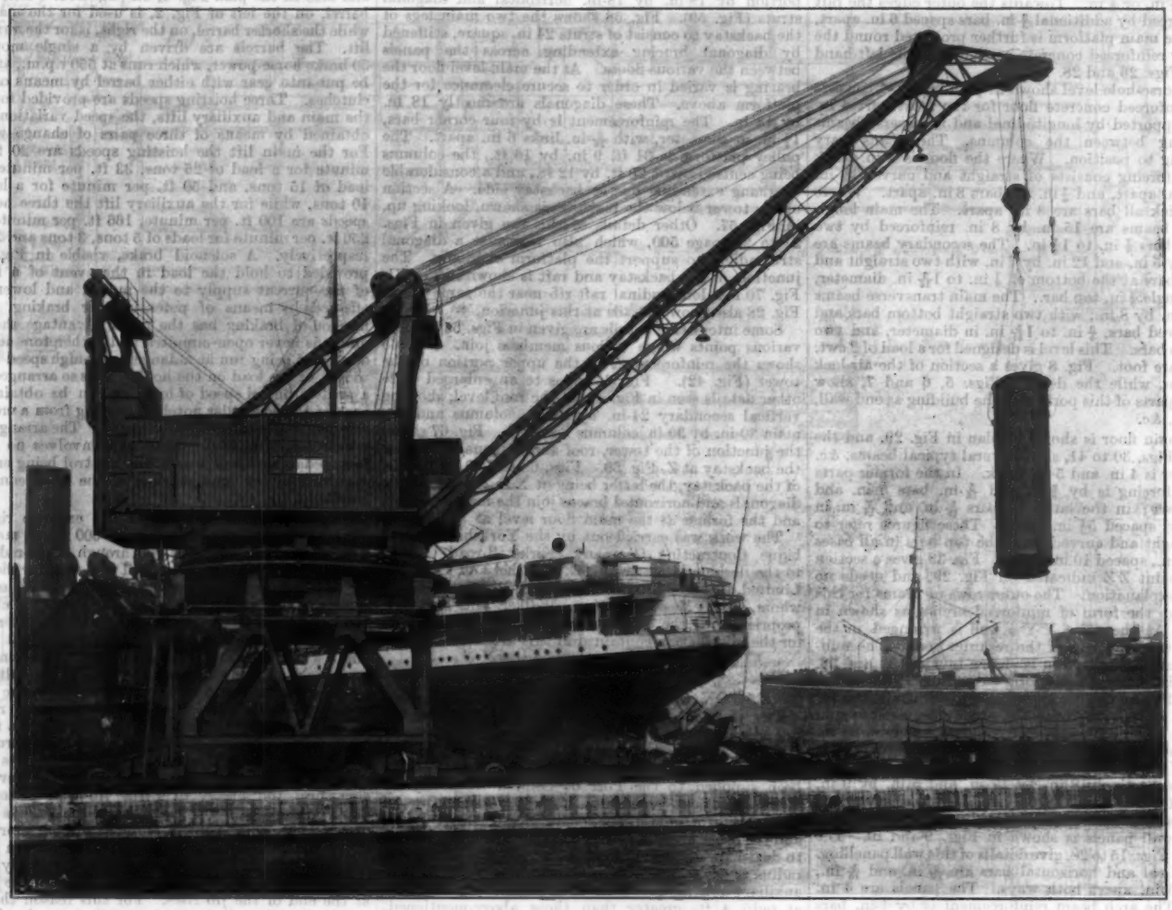


Fig. 1.

form provided at the top of the travelling carriage, and distinguishable by the hand rail in Fig. 1, but more clearly shown in Fig. 5, gives access to the machinery house and driver's cabin for any position of the revolving structure. The crane is operated by direct current at 500 volts, supplied to the crane from bare conductors fitted in a reinforced concrete conduit indicated by dotted lines in Fig. 3, near the left-hand running rail. The current collectors, it may be mentioned, are suspended from the travelling carriage so as to permit a certain amount of lateral movement, due to the clearance between the wheel flanges and the rails, without causing the plough bar to bind in the conduit slot.

We understand that Messrs. Stothert and Pitt, Limited, have in hand a large number of cranes of the same type, including several additional ones ordered by the Port of London Authority.

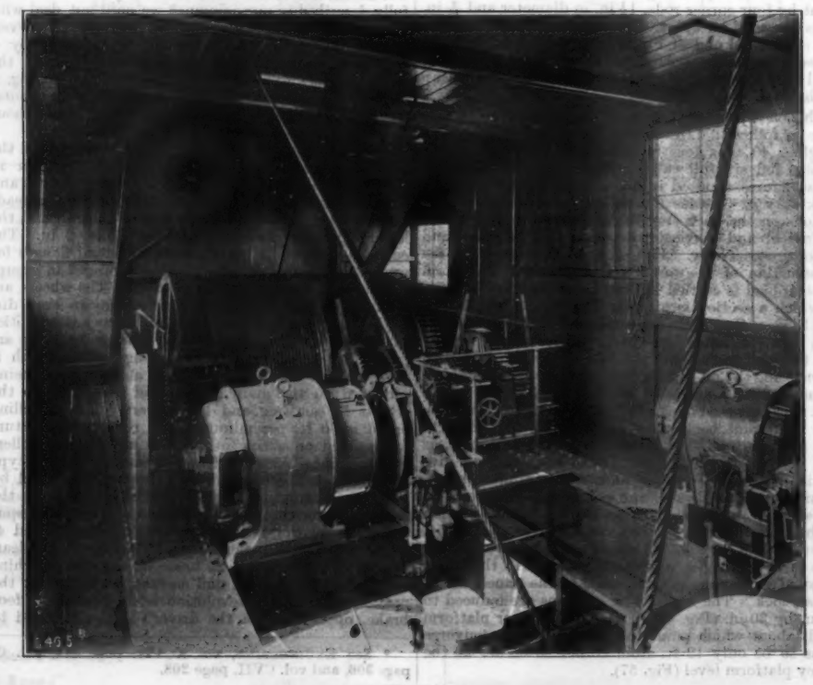


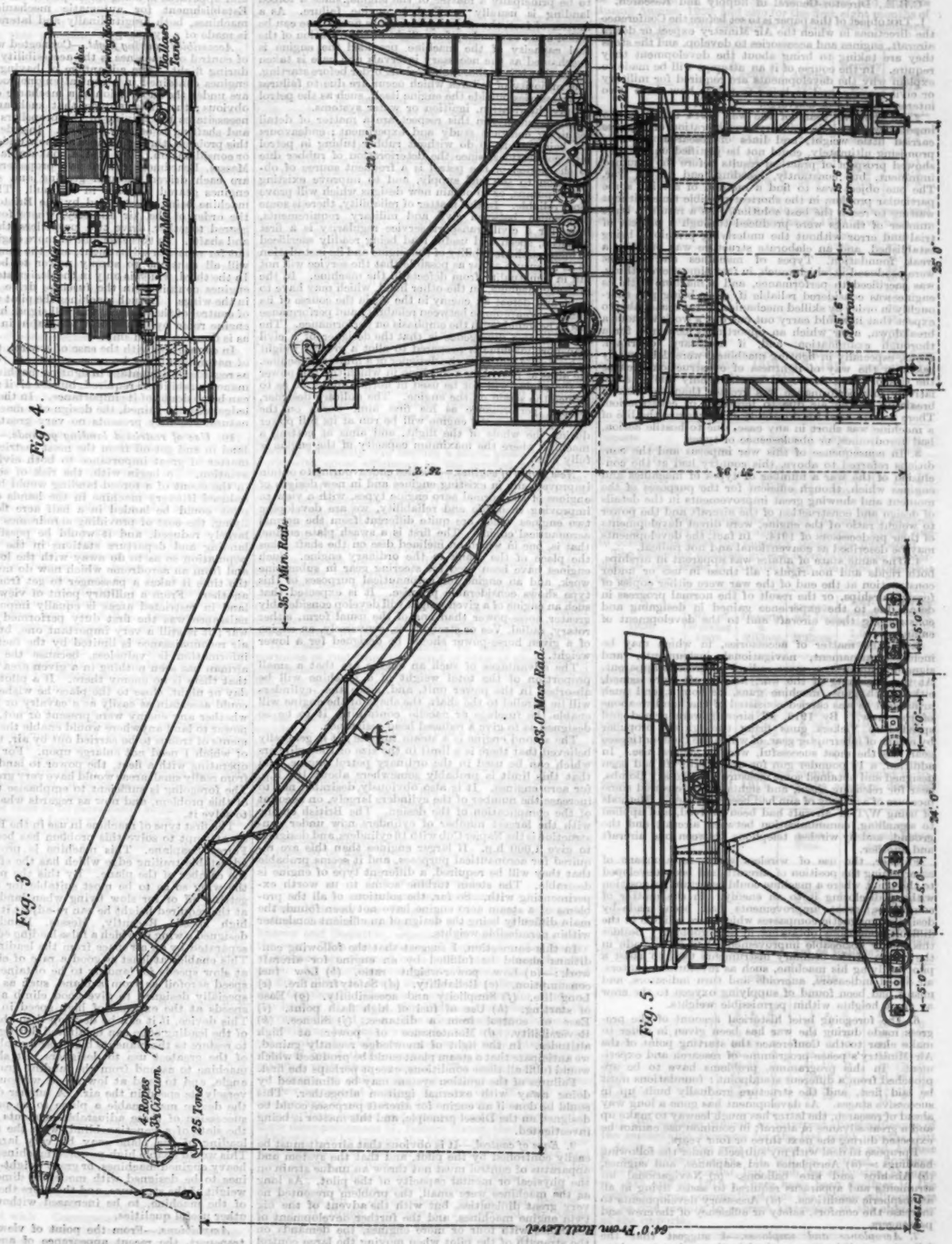
Fig. 2.

The Transmutation of Elements.—When lecturing on radioactivity and isotopes before the Chemical Society last spring, Professor F. Soddy remarked that if a chemist were given some lead, perfectly free from silver, and found silver in it after a time, and if after removing that silver, silver reappeared in the lead in the course of time, such a credited observation would ruin the theory of the invariability of the elements. We do not know whether or not Professor Soddy chose this example purposely, but it is curious that Laurent Naudin speaks in the *Moniteur Scientific* of last June, vol. x, pages 120 and 121, of actual observations to this effect having been made by the late distinguished chemist Schützenberger in 1880, at the Collège de France. Schützenberger had some pure lead; he dissolved it in gaseous chlorine and reduced the lead chloride produced, by hydrogen at high temperature; he then found traces of silver in the lead. This was repeated several times, always with the same result. Naudin was Schützenberger's assistant at the time. Unfortunately Naudin gives no details beyond the few words we have reproduced.

25-TON ELECTRIC CRANE WITH TOPLIS LUFFING GEAR.

CONSTRUCTED BY MESSRS. STOTHERT AND PITT, LIMITED, ENGINEERS, BATH.

(For Description, see Page 501.)



THE PRESENT POSITION OF AIRCRAFT RESEARCH AND CONTEMPLATED DEVELOPMENTS.*

By Air Vice-Marshal Sir E. L. Ellington, K.C.B., C.M.G., C.B.E., Director-General of Supply and Research.

1. The object of this paper is to set before the Conference the directions in which the Air Ministry expect or desire aircraft, engines and accessories to develop, and the steps they are taking to bring about the development they require. In the course of it an attempt will be made to explain why the developments are required for military or civil reasons, and to bring to notice how these two interests conflict or converge.

2. In the five years of the war, 1914 to 1918, the impetus was entirely military, consideration of expense carried little weight, and lines of research, however promising ultimately, could not be justified unless they showed prospect of practical results before the assumed imminent, but constantly, receding, end of the war. The one object was to find a method of solving some particular problem in the shortest possible time without waiting to reach the best solution. As a result, a large number of things were produced through a process of trial and error without the underlying principles being established, and an elaborate structure was built on a weak foundation. Types of machines and engines were produced in which much, in fact almost everything, was sacrificed to performance, and a machine with its engine was considered reliable if, after being put thoroughly in order by skilled mechanics, it was reasonable to expect that it would carry out one day's work without a breakdown, after which an opportunity occurred for a thorough examination, and, if necessary, overhaul. Risks, especially in fighting machines, were deliberately taken in the way of lightness of construction because the risk of being destroyed by the enemy due to a relatively low performance was greater than the risk of break up in the air due to lightness of construction. There was no need for durability in war, since the life of a machine was short in any case, due to hostile action, bad aerodromes, or obsolescence of types.

3. In consequence of this war impetus and the conditions referred to above, this country had at the conclusion of the war a number of types of machines and engines which, though efficient for the purposes of the moment and showing great improvements in the details of design and construction of the aircraft and the power to weight ratio of the engine, were direct developments of their predecessors of 1914. In fact, the developments may be described as conventional and not radical.

4. The same state of affairs was apparent in airships, both rigids and non-rigids; all those in use or under construction at the end of the war were either copies of foreign airships, or the result of the normal progress in detail due to the experience gained in designing and constructing these aircraft and to the development of engines.

5. In the matter of accessories, in which may be included armament, navigational instruments, and signalling apparatus, more radical progress is apparent. At the beginning of the war, no aircraft were armed, either with guns, machine guns, or bombs, and such armament as was carried consisted of the hand weapons of the crew. By 1918, all aircraft were armed and speeded-up Vickers guns firing through the propeller by means of interrupter gear, of which the Constantinesco gear was the most successful, were in general use. In addition, a 1½ pounder gun for use in aircraft had been designed and obtained some measure of success. Bombs, gear for releasing them, and sights which ensured some measure of accuracy of aim had been provided. Methods of using W/T in aircraft had been evolved, and applied to signalling, communication between aircraft and the ground, and by wireless telephone between one aircraft and another.

Further, the use of wireless waves as a means of ascertaining the position of aircraft had been developed to the point where a machine could ascertain its position without disclosing it to an enemy. In the matter of compasses, great improvements had been made by designing magnetic compasses which were reliable in the difficult conditions obtaining in an aeroplane. Besides this, many noticeable improvements had been made in the design of the ordinary instruments used to assist a pilot in flying his machine, such as revolution counters, air speed indicators, aneroids and turn indicators, and means had been found of supplying oxygen to the crew at great heights within permissible weights.

6. The foregoing brief historical account of the progress made during the war has been given in order to make clear to the Conference the starting point of the Air Ministry's peace programme of research and experiment. In this programme, problems have to be approached from a different standpoint: foundations must be laid first, and the structure gradually built up in successive stages. As development has gone a long way ahead of research, the latter has much leeway to make up and a great advance in aircraft in common use cannot be expected during the next three or four years.

I propose to deal with my subjects under the following headings:—(a) Aeroplanes and seaplanes, and engines. (b) Airships and kite balloons. (c) Navigational instruments and apparatus required to assist flying in all atmospheric conditions. (d) Accessory developments to increase the comfort, safety or efficiency of the crew and passengers.

7. *Aeroplanes and seaplanes.*—I suggest that the following qualities are required in the perfect aeroplane or seaplane:—(i) Reliability. (ii) Ease of control. (iii) Power to land and get out of the most restricted places. (iv) Good performance, that is high speed, quick climb and a ceiling sufficient to surmount any obstacles likely to be encountered, or to escape the enemy's attack. (v) Cheapness in construction and maintenance.

8. *Reliability.*—Reliability is popularly supposed to be principally a matter of the engine, since a forced landing is usually ascribed to engine failure. As a matter of fact, the majority of engines now in use can be relied upon to stand up for a flight of the duration of the fuel capacity of the machine, provided the engine is overhauled at the necessary intervals and care is taken to see that it is in thorough working order before starting. The majority of failures which occur are due to failures of accessories outside the engine itself, such as the petrol supply, lubrication, ignition or water systems.

Improvements in this respect are a matter of detail requiring constant study and experiment; endeavours are being made to do without rubber tubing in petrol pipe connections, since the deterioration of rubber due to the action of the petrol is a frequent source of obstruction to the fuel supply, and to improve existing petrol pumps, or to obtain new designs which will prove more reliable. In this matter of reliability, there is some divergence between civil and military requirements, since for a civil transport service regularity is a first essential, speed and useful load being readily sacrificed to increase the reliability of the engine and its installation so as to ensure as far as possible that the service will not fail in punctuality from defects in the machine. In the military machine, on the other hand, which may have to meet and defeat an enemy in the air in the course of its duties, a compromise between reliability and performance has to be found, with the emphasis on performance. The result of this divergence is that the designer of a civil transport machine is prepared to allot a greater weight to his power unit than the designer of a military machine. He aims at providing a machine in which the full power of the engine will not be used in normal flight, so as to reduce the strain on the engine. The military designer, having, performance as his first aim, works on the assumption that the engine will be run at its full power during the whole of the flight, and aims at getting a machine where the maximum capacity of the engine is fully used.

New Types of engines.—Besides endeavouring to obtain improvements in existing engines and in new designs of engines of the normal aero engine types, with a view to improving their life and reliability, we are developing two engines which are quite different from the normal aeronautical engine. The first is a swash plate engine, that is, one in which an inclined disc on the shaft takes the place of the crank in the ordinary engine. Such engines have been used for steering gear in submarine work, and an engine for aeronautical purposes of this type shows considerable promise. It is expected that such an engine of a given weight will develop considerably greater horse-power than one of the usual form, either rotary, radial, Vee or straight, or, conversely, an engine of a given horse-power should be designed for a lower weight.

The advantages of such an engine are that a small proportion of the total weight of a machine will be absorbed in the power unit, and, since the cylinders will lie parallel to the shaft, the shape of the engine will enable the fuselage or nacelle containing it to be so designed as to give a reduced head resistance.

The second engine is a steam turbine; it is generally believed that there is a limit in the size of the cylinders which can be used in the ordinary petrol engine, and that this limit is probably somewhere about 100 h.p. for aero engines. It is also obviously desirable not to increase the number of the cylinders largely, on account of the complication of the design. The British engine with the largest number of cylinders now under construction is the Napier Cub with 16 cylinders, and designed to give 1,000 h.p. If larger engines than this are required for aeronautical purposes, and it seems probable that they will be required, a different type of engine is desirable. The steam turbine seems to us worth experimenting with. So far, the solutions of all the problems of a steam aero engine have not been found, the main difficulty being the design of an efficient condenser within permissible weights.

In this connection, I suggest that the following conditions should be fulfilled by an engine for aircraft work:—(a) Low power-weight ratio. (b) Low fuel consumption. (c) Reliability. (d) Safety from fire. (e) Long life. (f) Simplicity and accessibility. (g) Ease of starting. (h) Use of fuel of high flash point. (i) Ease of control from a distance. (j) Silence. (k) Reversibility. (l) Maintenance of power at high altitudes. In the light of knowledge recently gained, we anticipate that a steam plant could be produced which would fulfil all these conditions, except perhaps the first.

Failures of the ignition system may be eliminated by doing away with external ignition altogether. This could be done if an engine for aircraft purposes could be designed on the Diesel principle, and this matter is being investigated.

9. *Ease of control.*—It is obvious that aircraft must be easily controlled by the pilot, and that the system and apparatus of control must not throw an undue strain on the physical or mental capacity of the pilot. As long as the machines were small, the problem presented no very great difficulties, but with the advent of the big twin engine machines, and the further development of machines with four or more engines, the demands on the strength of the pilot when moving the large control surfaces through long leads began to approach the physical limit of the ordinary man. The number of engine controls to be worked by the pilot, and the complication of the petrol supply put a very severe strain on the mental capacity of the pilot. In order to reduce the physical effort required by the pilot, control surfaces are balanced, and we are endeavouring to reduce the friction in the long leads which actuate them, in various ways. Mechanical means of moving the control surfaces are also being developed. For some years now large boat seaplanes have been provided with servo-motors for this purpose, and apparatus is being developed at the Royal Aircraft Establishment for automatic mechanical control of machines, both longitudinally and laterally, where use is made of a gyroscope.

Accessibility during flight.—Connected with the matter of control of machines is the accessibility of the engines during flight. The advantage of having the engine or engines contained in a central engine room where they are under the supervision of a mechanic during flight is obvious; the disadvantage that such an arrangement necessitates the driving of the propellers through gears and shafting is equally obvious. In order to investigate this problem, three machines are now under construction or consideration. The first, a boat seaplane designed by Messrs. Beardmore, where two propellers in the wings are each driven through gearing and shafts by two engines geared together in the hull. The second is a machine being constructed by the Bristol Company to the order of the Air Ministry, where four engines, all geared together, drive two propellers through gearing and shafts. In this case, one or more engines can be cut out for repair or adjustment, and the remaining engines will all continue to supply power to both propellers. In the third, which is only in the design stage, one or two engines contained in the fuselage drive two propellers in the wings. In such machines the pilot will be relieved of control of the engines, and will signal his orders to the engine room by means of a telegraph, in the same way as is done on board ship.

In connection with the ease of control, the importance of natural stability becomes apparent. Opinions differ as regards its advantage in fighting machines where great manœuvrability is required, but for civil machines there can be no doubt of its importance. In the light of knowledge recently gained, the design of a machine with good natural stability presents no very great difficulty.

10. *Use of restricted landing grounds.*—The power to land in and get off from the most restricted places is a matter of great importance to both civil and military aviation. To begin with, the risk of serious accident in the event of a forced landing would be very greatly reduced if every machine in the hands of an ordinary pilot could be landed in a half acre field. For civil flying, the cost of providing aerodromes would be very largely reduced, and it would be possible to provide landing and departure stations in the big centres of population so as to do away with the long journeys to and from an aerodrome which now do much to increase the time it takes a passenger to get from one place to another. From a military point of view, the power to land in restricted areas is equally important. Reconnaissance was the first duty performed by aircraft in war; it is still a very important one, but the value of air reconnaissance is limited by the fact that negative information is valueless, because the fact that the airman has seen nothing in a given area does not mean that there is no enemy there. If a pilot could land by day or night, close to the place he wishes to search, he could ascertain as easily as a cavalry or infantry patrol whether any enemy were present or not. Further, the power to land anywhere would enable the tactical movements of troops to be carried out by air, the possibilities of which I need not enlarge upon. For aeroplanes co-operating with a fleet, the power to land in and get off from really small areas would have very great advantages. The foregoing is sufficient to emphasise the importance of this problem, and now as regards what is being done to solve it.

The first type of machine in use in the R.A.F. in which an attempt to solve this problem has been made is the Fairey Seaplane. This machine is provided with an adjustable trailing edge which has the effect of varying the camber of the plane. By this the pilot can adjust the wing so as to be most suitable for climbing when getting off or for slow flying when landing, and when at the required height he can re-adjust it so as to give a high speed. Recently, Messrs. Handley-Page have designed a wing in which a false leading edge is provided, separated by an air space from the leading edge proper. This enables at least as good a rate of climb or control at slow speeds for landing to be obtained from a high-speed aerofoil as from a plane, such as the R.A.F. 19, specially designed to give good climb and low landing speeds at the expense of high speed in normal flight. This device, if it can be developed so that the attitude of the leading edge can be altered during flight in order to restore to the plane its high speed qualities, should be of the greatest use to designers. It should enable a machine to ascend from the landing ground at a steep angle, and to land at low speed without affecting adversely its speed in the air. A further development of the device may enable a plane to be provided with a succession of these adjustable elements something like the slats of a venetian blind, with the result that the loading of the plane may be very largely increased. This would enable high-powered machines, and therefore heavy engined machines, or great weight-carrying machines to be designed with moderate dimensions, or the weight of the structure, and therefore the safety and life of the machine, to be increased without reducing its other useful qualities.

Amphibians.—From the point of view of civil aerial transport, the recent appearance of amphibians is an event of some importance. In this country of short distances, highly developed land communications and numerous areas of dense population, one of the obstacles to the general adoption of aerial transport is the distances which have to be traversed by car between the passenger's

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home and the departure aerodrome, and the distance between the landing ground and his destination. This country is also one of numerous waterways penetrating the areas of dense population. The advantages of a machine which can land or get off water or an aerodrome indifferently are obvious.

The helicopter.—I doubt, however, whether the problem will be completely solved before the advent of the helicopter. A number of people in various countries are working at this problem, but most are, I think, working on the wrong lines. They aim at producing a machine which is entirely dependent for its suspension in the atmosphere on some form of air screw which runs only as long as the engine is working. Consequently, if the engine fails, the machine will drop like a stone. They attempt to provide against this by supplying two or more engines. What is required is a machine which will automatically descend at a safe rate when the engine stops, in the same way as an ordinary aeroplane planes down in such circumstances. Whether a machine can be designed sufficiently simple in its details to be reliable in practical use remains to be proved; theoretically it can be done.

11. *Importance of performance.*—The necessary performance of a machine varies very greatly with the use to which it is to be put. Every machine, civil or military, must have sufficient speed to overcome the maximum effect of normal winds met with in the parts of the world in which it is to work. It must have sufficient climb and ceiling to surmount obstacles on leaving the aerodrome or to rise above high ground met with in the course of its work. These qualities of speed, climb, and ceiling can only be provided at the expense of the other qualities of the machine, such as the useful load and petrol capacity, cost of construction and maintenance. In a civil machine, the aim should be to keep the speed, climb, and ceiling as low as is consistent with the machine carrying out its flight in the time required in any reasonable atmospheric conditions. In a war machine, the maximum speed, climb, and ceiling is required, since a superiority over the enemy in these qualities enables a machine to bring about, or refuse, a combat with an enemy at the will of the pilot. We have here a very marked divergence in the aims of designers of civil and military machines, and this divergence will have a marked effect in engine developments. In the engine designed for a military machine, especially for a fighting machine, much, in fact almost everything—expense, fuel consumption, life, and even reliability—will be sacrificed to reduce the weight for a given horse-power, or to increase the horse-power for a given weight. We hope in time to get engines of a weight as low as 1 lb. per horse-power, and, as air-cooled engines are less vulnerable than water-cooled, the former are being developed. No satisfactory rotary engine much over 200 h.p. has yet been produced, and no satisfactory V air-cooled engine over 140 h.p. The most promising line of development is the radial engine, and the A.B.C., Cosmos and the Siddeley radial engines designed to give from 300 to 420 h.p. are in an advanced experimental stage, and great hopes are entertained of the ultimate success of the type. It is generally believed that with about 200 h.p. the limit of the rotary engine has been reached, but a designing firm is investigating a differential rotary engine in which the crankshaft and propeller revolve in one direction and the cylinders in the other.

12. *Cheapness of construction and maintenance.*—Cheapness of construction and maintenance is of first importance in a civil machine in order that air transport may be financially practicable. As cheapness of construction goes with simplicity, and therefore ease and rapidity of construction, it is of great importance for war purposes, since it will enable the requirements of the Air Force in war time to be more easily supplied. Cheapness of maintenance, a factor of which is low labour cost, means fewer men employed in maintaining each machine in the air, and as we have seen in the recent war, the ultimate deciding factor is man power, the importance of this needs no emphasis. Aircraft as the war has left them, both the aircraft proper and the engines, are undoubtedly flimsy structures requiring continual looking after by skilled mechanics and frequent and lengthy overhaul. The wood and fabric which form a large part of the material used require careful selection, and have short lives. Deterioration when exposed to the weather is rapid, necessitating the provision of sheds and hangars. The use of large numbers of bracing wires, besides adding to the complication of the construction and maintenance, adds largely to the resistance, and so reduces the efficiency of the machine. Moreover, in a fighting machine, they obstruct the view and field of fire, and are liable to be shot away, resulting in a demand for their duplication. It is desirable, therefore, to seek a design and system of construction which will provide a stronger and more durable machine, and which will remain tuned up without constant adjustments and supervision by skilled personnel. The solution of this problem lies probably in the use of metal. Considerable progress has already been made in this direction, but in this country it has hitherto taken the form of the reproduction of the wooden machine in metal rather than a radical change in the system of construction. In my opinion, however, this is not the most promising way in which to use metal. Towards the end of the war, the Germans produced an all-metal monoplane with planes of deep section. This enabled the cantilever system to be employed, and all external bracing wires or members to be dispensed with. Corrugated metal sheeting takes the place of fabric in the wing and fuselage coverings. Since the Armistice, a civil passenger-carrying machine has been developed by Junker from this which appears to have been most successful in Germany and the United States of America. Such a machine should require little adjustment, and should not deteriorate from exposure to the weather, though its behaviour when exposed to the wide range of temperatures met with in the East requires investigation. Several designers in this country are studying similar designs. If it is found possible to introduce into planes so constructed, elements which can be adjusted in flight at the will of the pilot so as to enable a heavily loaded machine to rise from a confined aerodrome, and land at a low speed while maintaining a high speed in the air, a very great step will have been made in the development of the aeroplane. In the Junker machine, the engine is contained in the fuselage, following normal practice in this respect. A machine is now being designed in this country in accordance with the Voyewodski patents, in which the depth and structure of the wings is such that engines can be installed within the wing structure. Such model tests as have so far been carried out tend to show, as might be expected, that aerodynamically there are great advantages in such a design. It is further suggested that the undercarriage should draw up in flight within the main structure of the machine. Should this prove practicable, we shall be approaching finality in the matter of reduction of resistance in a machine driven by an airscrew.

Forced induction and variable pitch propellers.—Another development which aims at increasing the efficiency of aircraft is forced induction for the engine combined with a propeller with adjustable blades. As an aeroplane ascends, the air in which it is moving becomes rarefied, and the volume of oxygen taken into the cylinders at each stroke decreases, with a consequent decrease in the power developed during the stroke. By means of forced induction, a greater quantity of air and therefore of oxygen is forced into the cylinders than that which would be forced in by atmospheric pressure. The most promising method of doing this appears to be by means of a fan worked by an exhaust turbine, but so far we have not been able to construct a turbine which will not be burnt by the hot exhaust gases. In this connection it should be pointed out that forced induction is useless without a variable pitch propeller, for by forced induction the engine is made to give out the same horse-power at a height as in the dense atmosphere on the ground, but the propeller which near the ground is working efficiently will require a much greater pitch to work with equal efficiency in the rarefied atmosphere at a height, and conversely. Thus it will be seen that the pitch of a propeller should be different at the various engine and aeroplane speeds if the maximum efficiency of the engine and propeller is to be obtained. If, further, the variable pitch propeller is developed to the point where the blades can be completely reversed, the pilot will be provided with an efficient air brake to assist him in reducing the speed of landing and in pulling up after landing has been effected. Although much time and work has been expended on variable pitch propellers and considerable progress made, no completely satisfactory design has been evolved which can be relied upon to stand up to the great stresses to which propellers are subjected by modern high-powered aero engines.

13. *Fuels.*—Reference should be made to the importance of fuel from the point of view of cheapness of maintenance. Hitherto, only the best grade of petrol has been used for aero engines, and this, besides being costly, is highly inflammable, and fire after the crash in aircraft accidents, due to the high degree of inflammability of the fuel used, is the most disturbing feature of these accidents. The problem is to find a fuel which is cheaper in itself and more economical as regards the quantities used, that is to say, one which will show a lower consumption than 0·5 lbs. per horse-power per hour, the approximate average consumption of the engine of to-day, and less liable to catch fire in an accident. Much research work has been done in investigating alternative fuels to petrol, and probably the solution will be found either in the application of the direct injection principle to internal combustin aero engines so as to enable heavier oil fuels to be used, or by the use of the steam turbine, mentioned earlier in this lecture.

(To be continued.)

THE HISTORY OF SCIENCE.—Last year University College, London, arranged for a course of lectures on history and literature, especially for people coming from the war. This year courses of lectures on the History of Science are planned on a much more comprehensive scale. An introductory public lecture was delivered by Sir William H. Bragg in University College, on Thursday, October 7. There is a real movement for studying the history of science, Sir William remarked, and the movement would grow. The scientist always felt the need of verifying his data by experiment; everything that we see is only relatively true, and we are only extending the work of our fathers, not disproving it; we can never be satisfied with what we know. The influence of science on history, on philosophy and religion, is great; there are few competent to teach it, however. We may study the history of science by following the history of great men in their success and appreciation (Faraday), and in their disappointment (J. Robert Mayer, the Conservation of Energy), or by tracing the history of ideas and of their applications. Sir William also pleaded for greater, and more general facilities in scientific education outside the universities. The courses of lectures which are to be delivered at various periods during the coming winter session are on "Developments of Physical Science" (Sir W. H. Bragg, Professor E. J. Garwood, Mr. Orson Wood); on "Egyptian Science" (Professor Flinders Petrie); on the "History of Biological and Medical Science" (Dr. Charles Singer and Professor J. P. Hill); on "Elementary Astronomy Treated Historically" (Professor L. N. G. Filon); and on the "History of Mathematics up to the Eighteenth Century" (Mr. T. L. Wren). Visits to museums will be arranged in connection with the lectures.

THE IMPROVEMENT IN OUR FOREIGN TRADE.

THE following tables, compiled for the British Commonwealth Union, give to the nearest 100,000*l.* (expressed as a decimal of a million), the imports and exports during August, 1920, and also for the first eight months of 1920, together with the figures for other useful comparative periods:—

—	August, 1920.	August, 1919.	Monthly Average for 1919.	August, 1913.
Imports	153·3	148·7	136·0	56·0
Exports (British produce)	114·0	74·8	66·5	44·1
Exports (Foreign and Colonial produce)	13·4	15·3	13·7	8·1
Total exports	128·3	90·1	80·2	52·2
Adverse balance	25·0	58·6	55·8	3·8

The adverse balances for each month of this year and each of the corresponding months of 1919 have been:—

	1920.	1919.
January	52·2	32·6
February	62·0	54·7
March	45·9	43·7
April	40·5	40·3
May	26·7	50·3
June	34·0	46·4
July	8·6	76·2
August	25·0	58·6
Total	294·9	462·3

The following is a comparative statement for the first eight months of 1920, 1919 and 1913, respectively. Eight months ended August 31:—

	1920.	1919.	1913.
Imports	1,340·0	1,018·1	496·4
Exports (British produce)	880·8	474·8	348·3
Exports (Foreign and Colonial produce)	167·1	82·5	75·5
Total exports	1,056·9	557·3	423·8
Adverse balance	283·1	460·8	72·6

It will be noticed that the total of the monthly adverse balances differs from the aggregate figures; this is due to corrections after the monthly totals are published.

The following analysis gives a more favourable appearance to the trade of August than the bare statement of values:—

1920.	No. of Working Days.	Imports, £ Millions.	Average per Day £ Millions.	Estimated Weight, 1,000 Tons.	Average Weight per Day, 1,000 Tons.
January	27	183·5	6·80	3,316	124
February	25	170·5	6·82	2,892	116
March	27	176·6	6·54	3,550	131
April	24	167·1	6·96	3,680	153
May	25	166·3	6·65	3,876	155
June	26	170·5	6·56	4,150	160
July	27	163·8	6·07	4,195	155
August	25	153·9	6·13	4,302	172

The estimated weights for the month of August in the years 1920, 1919 and 1913, and the average declared value per ton of all imports were as follows:—

—	Imports. 1,000 Tons.	Average Declared Value per Ton.
		£ s. d.
August, 1920	4,302	35 17 0
August, 1919	3,950	37 13 0
August, 1913	4,808	11 9 0

The average declared values for each of the first eight months in 1920, 1919 and 1913, are as follows:—

—	1920.	1919.	1913.
	£ s. d.	£ s. d.	£ s. d.
January	55 6 0	43 4 0	15 16 0
February	59 1 0	46 9 0	16 5 0
March	49 15 0	45 5 0	15 6 0
April	45 9 0	45 13 0	14 14 0
May	42 18 0	41 19 0	13 13 0
June	41 2 0	42 6 0	11 16 0
July	39 2 0	41 13 0	11 7 0
August	35 17 0	37 13 0	11 9 0

It still remains difficult to interpret the significance of the remarkable averages for the last eight months, but a decline of 40 per cent. between February and August is very extraordinary. It will be noticed, however, that there were similar, but much less extensive, changes in 1913 and in 1919. There have been declines in the values of some commodities, but the change still appears to be due mainly to a great alteration in the character of the imports.

THE INSTITUTE OF METALS.—The annual general meeting of the Institute of Metals will be held on March 9 next, in the Institution of Mechanical Engineers, Storey's Gate, Westminster, and the annual dinner will take place on the same evening. The May lecture will be delivered by Professor T. Turner, M.Sc., on May 4.

INTERNAL-COMBUSTION CABLE PLOUGHING ENGINE.

CONSTRUCTED BY MESSRS. J. AND H. McLAREN, LIMITED, ENGINEERS, LEEDS.

Fig. 1.

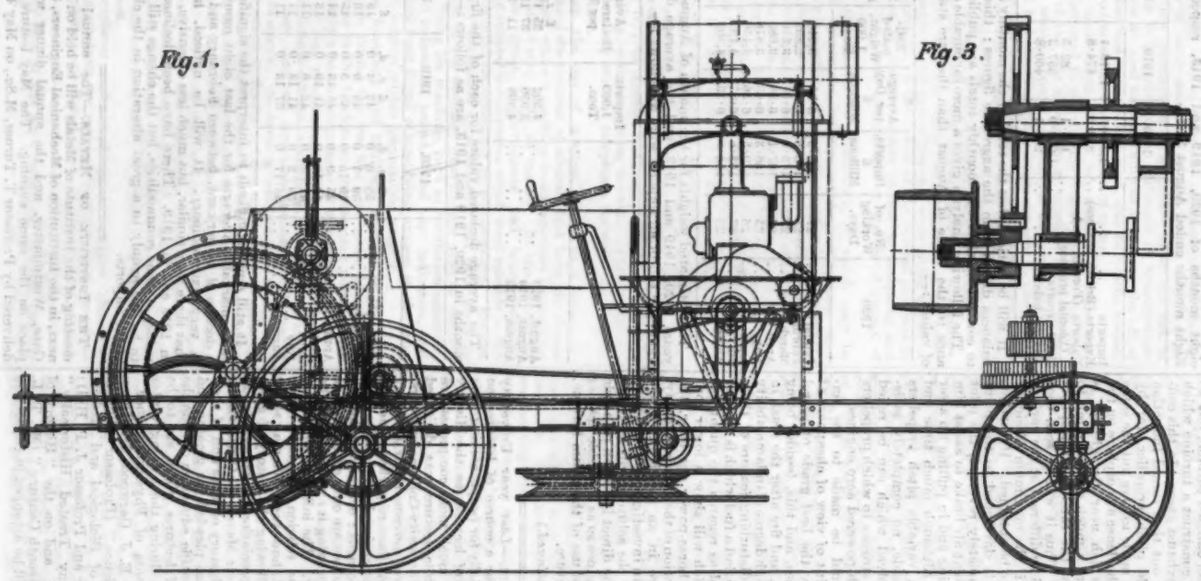


Fig. 3.

Fig. 4. END VIEW LOOKING FROM BACK OF WINDLASS.

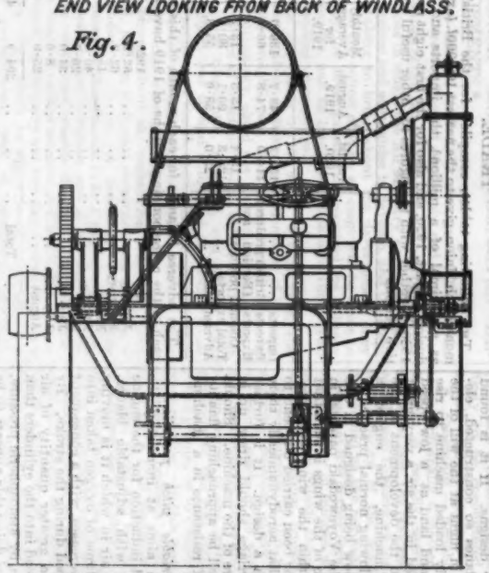


Fig. 2.

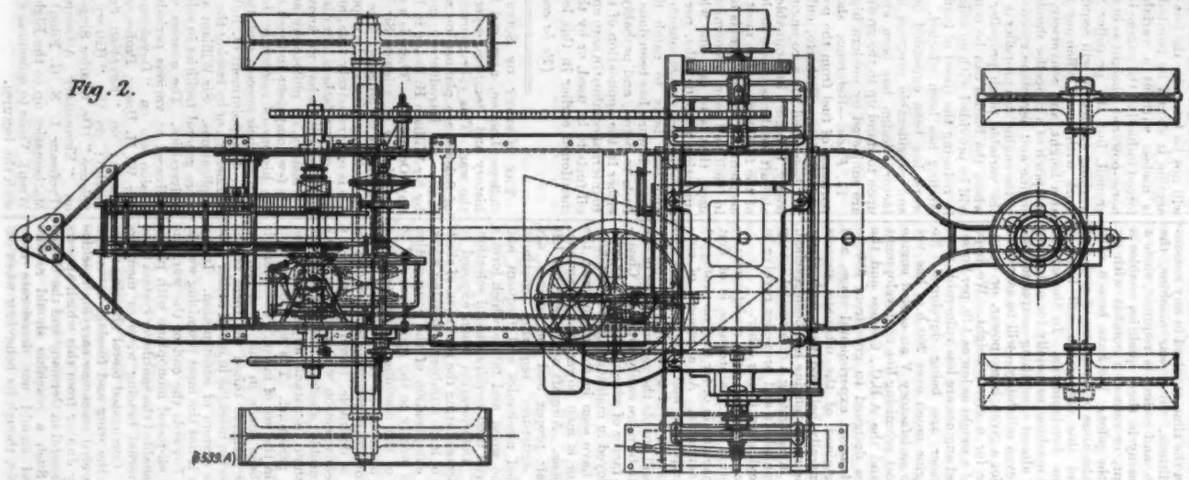
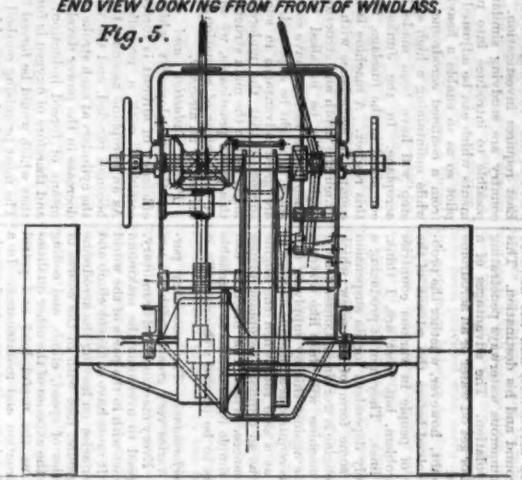


Fig. 5. END VIEW LOOKING FROM FRONT OF WINDLASS.



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CLASS V of the recent trials for ploughing tractors &c., held near Lincoln attracted only two entries, both by makers hitherto associated with steam practice. This class was for internal-combustion double engine sets for cable ploughing, capable of working by rope haulage three or four-furrow ploughs, cutting 10 in. wide and 8 in. deep, the machines to comply with the Light Road Locomotives Acts. The set entered by Messrs. J. and H. McLaren, Limited, Midland Engine Works, Leeds, is illustrated in Figs. 1 to 9, on this and the opposite pages, and is conspicuous for its light weight and moderate power. The weight is only 3½ tons for each engine with fuel and spuds, and the power developed is 32 brake horse-power. Of our illustrations Figs. 1 and 6 give section and elevation, and Fig. 2 is a plan of the machine; Figs. 4 and 5 are end elevations; Fig. 3 is an illustration of the drive of the belt pulley, while Fig. 7 gives a section through the front axle and fore-carriage, and Fig. 8 a section through the back axle. Fig. 9 is also a cross-section.

A four-cylinder "Dorman" engine having cylinders 4¼ in. diameter by 5½ in. stroke, is used, arranged to burn paraffin, petrol being used on starting-up till the vaporiser gets hot. Once hot, the engine will again start on paraffin without the use of petrol, after standing any time up to 20 minutes. This is of importance, for arrangements are made to stop each engine while the other is ploughing and re-start without the starting handle.

The chief feature of the design is that in place of the horizontal winding drum usual in steam ploughing practice, the drum is placed vertically at the rear of the engine. From this drum the rope is led round a large diameter pulley under the centre of the machine. This pulley is placed centrally between the wheels so as to equalise the side pull on them. The drum

INTERNAL-COMBUSTION CABLE PLOUGHING ENGINE.

CONSTRUCTED BY MESSRS. J. AND H. McLAREN, LIMITED, ENGINEERS, LEEDS.

Fig. 6.

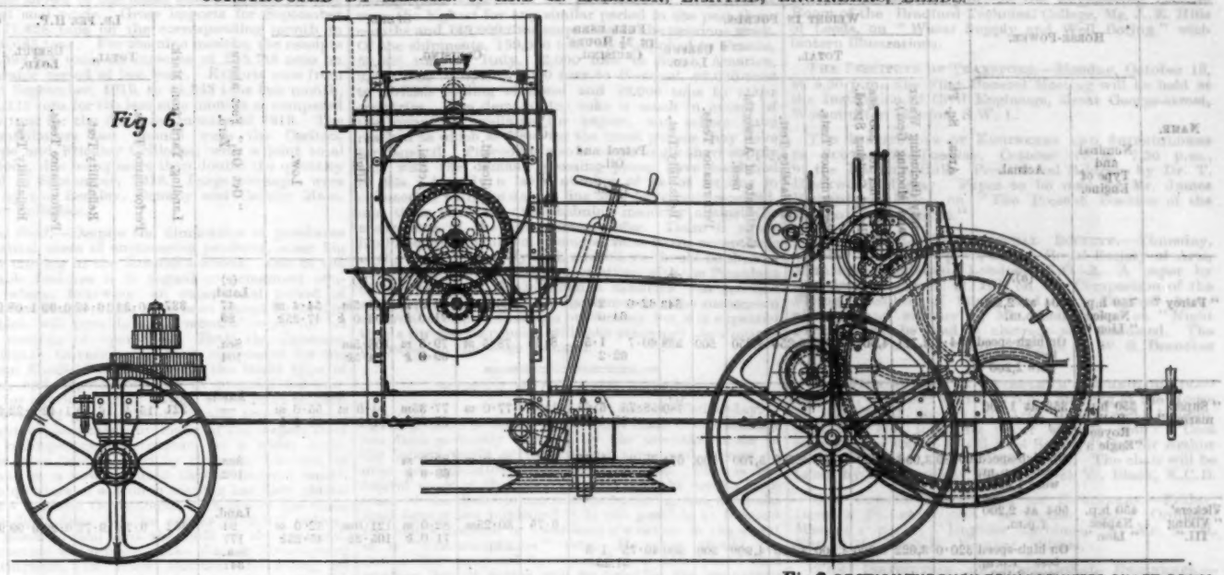


Fig. 9. SECTION THROUGH DRUM COUNTER SHAFT, DRUM SHAFT, AND VERTICAL TRAVELLING GEAR. LOOKING FROM FRONT.

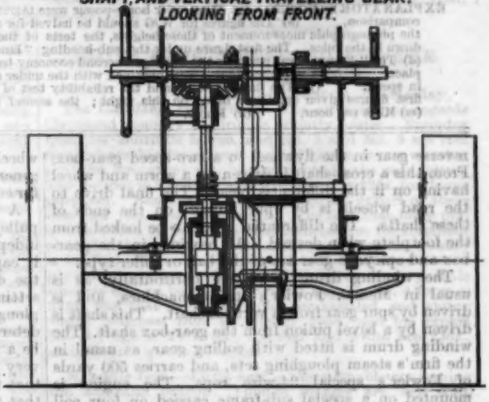


Fig. 8. SECTION THROUGH HIND WHEELS AND AXLE PIPE.

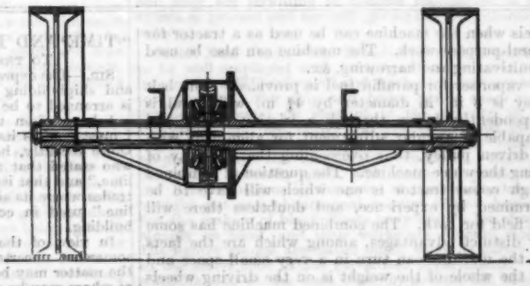
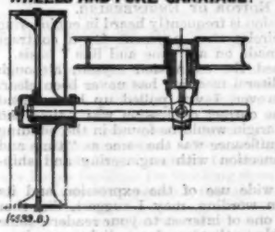


Fig. 7. SECTION THROUGH FRONT WHEELS AND FORE CARRIAGE.



(6539.B.)

is relatively narrow, and with this arrangement a coiling gear is considered unnecessary. A considerable amount of complication is thereby saved. With a horizontal drum some form of coiling gear is absolutely essential. Otherwise when ploughing on uneven ground the rope coils entirely at the top or bottom of the drum. In order to equalise the weights on the wheels the engine is placed well forward. It is placed across the main frame and carried on a T-bar frame, which also carries the radiator, fuel tank, &c., and the brackets of the first-motion shaft. It may be mentioned that the horizontal pulley is provided with guides so that the rope may be led to it from any angle over a wide range.

The drive is to a first-motion shaft through a friction clutch and spur gear giving considerable reduction. From this shaft a second motion shaft, placed at the back of the vehicle, is driven by a long roller chain, (Fig. 6) adjusted by means of a jockey pulley. The winding drum is driven from the second-motion shaft by spur gear and pinion, which slides in and out of gear as required. A friction brake is fitted to the winding drum inter-connected with the pinion, so that the brake is always on when the pinion is out of gear.

For the propulsion of the vehicle a vertical shaft is driven from the second-motion shaft by bevel gears which slide in and out of gear. Two bevels are provided, one for ahead and the other for astern. This vertical shaft drives a worm and wheel on the back axle. The ratio of gear from the engine to the second motion shaft can be changed in 3 minutes by changing the pinion and wheel. In this way the ratio of gear both to the winding drum and the back axle can be altered.

A special feature of this set is the arrangement for allowing each engine to be stopped while the other is doing the pulling, and then restarted. This is effected by connecting the engine to the winding drum in such a way that it is turned in the right direction for starting-up, by the other engine while it is pulling. A pinion gears with the spur wheel of the winding drum and drives a countershaft by a chain, which again drives a sprocket on the engine shaft by another chain. This can be connected to the crankshaft by a clutch, and thus the engine is turned. When the driver sees that the other engine has nearly completed its pull he starts his engine up in this manner. In practice this starting arrangement appeared to work excellently during the trials.

The back axle is a steel casting bolted to a channel steel frame. The latter is bent in at the front and back so as to meet, and no diagonal struts are used. This machine is a very interesting development of a double ploughing set of moderate power and very light weight.

FOWLER PLOUGHING MACHINERY.

Messrs. John Fowler and Co. (Leeds), Limited, entered three distinct types of machines at the trials held recently at Lincoln by the Royal Agricultural Society and the Society of Motor Manufacturers and Traders. These we illustrate on page 510, on which Fig. 1 represents the engine of a double steam engine set which follows the general lines of the firm's double engine cable sets made now for some sixty years. The present design has, however, some special features.

It is moderate in size, being rated at 8 h.p. nominal, each engine weighing 12¼ tons complete with spuds and fuel. How conventional the nominal rating is may be seen from the fact that it is stated that this engine will develop continuously 80 i.h.p. when ploughing. In practice it easily does the same work as a motor ploughing set developing over 60 brake horse-power. In place of being compound, as has been the usual practice in this class of engine for some years, this set is simple, with a single cylinder, the diameter being 8 in. and stroke 12 in. Superheated steam is, however, used with a piston valve, and it is quite possible that the results obtained will be as satisfactory all round as with compounding. The superheater is arranged so that the tubes can be cleaned while the engine is at work by a steam jet worked from the footplate. Both cylinder and piston valve are entirely steam jacketed. The upright shaft is now carried in a bearing fixed in a spherical seating which allows for all variations in alignment due to boiler expansion.

For the rest the construction follows the general lines of Messrs. Fowler's practice. The boiler has screwed roof stays and works at 180 lb. pressure. It is fed by pump and injector. The crosshead works on a single slide bar, and the crankshaft is balanced. Two road speeds are provided of 2 m.p.h. and 4 m.p.h., and the ploughing speed is 3¼ m.p.h. The winding drum is placed as usual horizontally below the boiler, and is driven by a vertical shaft and bevel gear from the crankshaft, the bevel wheel sliding vertically on this shaft to be put in and out of gear. The usual coiling gear is provided.

The internal-combustion engine set for cable ploughing, entered in Class V at the Aisthorpe trials, is an interesting departure in mechanical ploughing. This machine is illustrated in Fig. 2, page 510. Generally it may be said that this machine contains many features of Messrs. Fowler's steam ploughing sets, combined with modern motor practice. The engine is vertical, with four cylinders, 5 in. diameter by 7½ in. stroke, and develops 60 brake horse-power at 1,000 r.p.m. It is placed longitudinally in the front of the machine, as is usual in motor practice. From the engine the drive is taken through an epicyclic

AIR MINISTRY COMPETITION, 1920.

Table of Data regarding Amphibians—arranged Alphabetically.

Name.	Horse-Power. Nominal and Type of Engine.	Horse-Power. Actual.	Area, Sq. Ft.	Weight in Pounds. Total. Empty (including Water and Mooring Gear).	Weight in Pounds. Total. With Fuel for 350 Sea Miles at Cruising Speed.	Weight in Pounds. Total. Performance Tests.	Weight in Pounds. Total. Reliability Test.	Weight in Pounds. Total. Certificate of Airworthiness.	Weight in Pounds. Useful Load. Performance Tests.	Weight in Pounds. Useful Load. Reliability Test.	Fuel used in 3¼ Hours' Cruising. Petrol and Oil. Total.	W/G	Speed. Cruising. Indicated.	Speed. Cruising. Actual.	Speed. High.	Speed. Low.	"Got Off" Feet above Zero.	Landing, Yards from Mark.	lb. per H.P. Total. Performance Tests.	lb. per H.P. Total. Reliability Test.	lb. per H.P. Useful Load. Performance Tests.	lb. per H.P. Useful Load. Reliability Test.	Lbs. per Square Feet. Performance Tests.	Lbs. per Square Feet. Reliability Test.
		(a).									(d)	(b)			(c)		(c) Land. Sea.							
"Fairey"	450 h.p. Napier "Lion"	504 at 2,200 r.p.m.									543 62·0 2·0 64·0	8·5	80·0 *m*	81·8 *m* 71·0 *k*	118·5*m* 103·0 *k*	54·4 *m* 47·25*k*	47 89	337	10·33	10·42	0·99	1·08	9·57	9·65
		On high-speed test r.p.m. were 2,200	544·2	3,771	4,507	5,207	5,250	5,250	500	538	60·7 1·5 62·2	8·65	78·5 *m*	79·5 *m* 69·0 *k*	108·5*m* 94·5*k*		Sea. 104							
											(f)						Land.							
"Supermarine"	350 h.p. Rolls Royce "Eagle 8"	352 at 1,800 r.p.m.									780 58·75 6·65 65·4	11·88	77·0 *m*	77·35*m* 67·25*k*	94·0 *m* 82·0 *k*	55·0 *m* 48·0 *k*	— 60	321	15·4	16·19	1·42	2·22	9·03	9·5
		On high-speed test r.p.m. were 1,900	600·0	3,996	4,720	5,420	5,700	5,700	500	674	75·0 1·75 76·75	8·8	80·0 *m*	80·0 *m* 69·6 *k*			Sea. 102							
Vickers' "Viking III."	450 h.p. Napier "Lion"	504 at 2,200 r.p.m.										9·75	80·25*m*	82·0 *m* 71·0 *k*	121·0*m* 105·2*k*	52·0 *m* 45·25*k*	Land. 94 177 Sea. 341	382	9·72	9·72	0·99	0·99	9·42	9·42
		On high-speed test r.p.m. were 2,190	520·0	3,622	4,200	4,900	4,900	4,900	500	500	49·75 1·5 51.25													

EXPLANATORY NOTES.—(a) Figures for horse-power were taken from the log books of the engines concerned. The revolutions per minute attained on the high-speed tests are given for comparison. (b) The figures for W/G should be halved for comparison with the similar figures for aeroplanes, published in A.M. Communique No. 607. (c) In order to facilitate the photographic measurement of these heights, the tests of the "Fairey" and the "Vickers" machines were carried out with a 275 yards run in lieu of the 400 yards distance laid down in the rules. The first figure under the sub-heading "land," gives the actual height attained in 275 yards, the second figure is the corrected height for the 400 yards distance. (d) The "Fairey" was permitted to undergo a second economy test owing to bad weather conditions on the first test. The figures for both tests are given in the order in which they took place. (e) The higher figures were obtained with the under carriage raised, the lower with the under carriage down. Similar alternative tests with the "Vickers" showed no difference in speed. (f) The first economy and the reliability test of the "Super-marine" were ended after 3 hours 10 minutes, owing to the fracture of an oil pipe on the engine. The first figures given are those based on this flight; the second are those based on a further 3¼ hours' flight at a low altitude in bad weather, on the last day of the competition. (*m*) Miles per hour. (*k*) Knots.

reverse gear in the flywheel to a two-speed gear-box. From this a cross-shaft is driven by a worm and wheel having on it the differential gear. The final drive to the road wheels is by spur pinions on the ends of these shafts. The differential gear can be locked from the footplate when desired. All bearings in the gear-box and epicyclic gear are of the ball or roller type.

The winding drum is placed horizontally, as is usual in Messrs. Fowler's steam machines, and is driven by spur gear from a vertical shaft. This shaft is driven by a bevel pinion from the gear-box shaft. The winding drum is fitted with coiling gear, as usual in the firm's steam ploughing sets, and carries 500 yards of Fowler's special 24-wire rope. The engine is mounted on a special sub-frame carried on four coil springs and fixed to the front end of the gear-box by a spherical joint, thus insulating the engine, radiator, &c., from the road shocks, and also from any distortion of the main frame in working. The main frame is of channel steel.

In order to avoid having to run the engine of the idle machine when the other engine is pulling, C.A.V. electrical self-starters are fitted and the magneto is of the "impulse starter" type. This arrangement appeared to work excellently during the trials, as each engine was always stopped when the other was pulling and started at once when required. This saves a considerable amount of petrol as compared with running the engine idle all the time. Petrol was used as fuel at the trials, but a paraffin carburettor can be fitted if desired. The weight of each machine is 6½ tons with spuds and fuel, and it is interesting to compare this with the weight of the steam set entered which was doing practically the same work, namely, 12½ tons.

An example of the self-contained plough was also entered in Class VII by Messrs. Fowler and Co. We illustrate this machine in Fig. 3, page 510. It has a four-cylinder engine mounted in the front of the machine, with cylinders 3¼ in. by 5½ in., giving 20 brake horse-power to 25 brake horse-power. From this a gear-box having two speeds and a reverse is driven by a plate clutch with pedal and hand lever control, all the shafts in the gear-box running on ball bearings. The main drive is by worm and wheel, and the final drive by pinion and gear-ring to the road wheels. Steering is by hand and power through independent brakes fitted on either side of the differential shaft. By applying either of these one wheel is held stationary and the power applied to the other turns the machine in a small space. The plough frame is independent of the main frame and can readily be disconnected by removing three pins, and replaced by two travelling wheels when the machine can be used as a tractor for general-purpose work. The machine can also be used for cultivating and harrowing, &c.

A vaporiser for paraffin fuel is provided. The belt pulley is 8 in. in diameter by 4¼ in. wide, and is independently driven through a friction clutch and is capable of angular adjustment for alignment with the driven pulley, thus overcoming the difficulty of setting the whole machine. The question of combined plough *versus* tractor is one which will have to be determined by experience, and doubtless there will be a field for both. The combined machine has some very distinct advantages, among which are the facts that the machine can turn in a very small space and that the whole of the weight is on the driving wheels and therefore available for adhesion.

AIR MINISTRY COMPETITION, 1920.

The table given above, officially communicated to us, gives the results of the Air Ministry competition of amphibian aeroplanes. Details of the machines were published in our issue of September 10 (page 343 *ante*). The Air Ministry announces:—

The Judges' Committee consider that the results achieved in the competition for amphibians show that a considerable advance has been attained. The conditions to be fulfilled were such as had received little attention in the past, and the competing firms deserve congratulation upon the enterprise they have shown. The committee are of opinion that the proportion of the monetary awards, laid down for this competition, does not adequately represent the relative standards of merit of the first two machines, and they recommend an increase in the amount of the second prize. The following sums have, therefore, been awarded:—

First Prize, 10,000*l.*—To Messrs. Vickers, Limited. Vickers' "Viking III" fitted with 450-h.p. Napier "Lion" engine (the third in the table).

Second Prize, 6,000*l.*—Messrs. Supermarine Aviation Works, Limited, Supermarine Amphibian fitted with 350-h.p. Rolls-Royce "Eagle VIII" engine (the second on the table).

Third Prize, 2,000*l.*—Messrs. Fairey, Limited, Fairey Amphibian fitted with 450-h.p. Napier "Lion" engine (the first on the table).

King's College London Old Students' Association (Engineering Faculty).—A luncheon will be held at the Holborn Restaurant at 1.15 p.m. on Wednesday, October 27, when the chair will be taken by Mr. C. H. Wordingham, C.B.E. Old students are requested to communicate with the Hon. Assistant Secretary, Mr. D. H. Kendon, King's College, W.C. 2.

"TIME AND LINE" OR "TIME AND LIME."

To the Editor of Engineering.

Sir,—The expression is frequently heard in engineering and shipbuilding circles that payment for a contract is arranged to be made on a "time and line" basis.

I have often used the expression myself, although I must confess its literal meaning has never been clear. Quite recently, however, I was pulled up by a friend who stated that the correct expression was "time and lime," and that its origin would be found in the building trades where its significance was the same as "time and line" used in connection with engineering and ship-building.

In view of the wide use of the expression and its somewhat uncertain wording, may I suggest, Sir, that the matter may be one of interest to your readers, some of whom may be able to throw a clearer light upon it.

Yours faithfully,
J. F. Powell.

Camcot, Crook Log, Bexleyheath, Kent.
October 4, 1920.

Agricultural Tractors for Siam and Singapore.—A despatch has been received in the Department of Overseas Trade reporting inquiries from the Agricultural Department of the Siamese Government for particulars regarding British-made tractors, especially of the chain-track type. It is suggested, therefore, that interested firms should forward particulars of their manufactures to H.B.M. Consul-General, Bankok, Siam. In connection with the foregoing, it may be mentioned that H.M. Trade Commissioner at Singapore is also desirous of receiving descriptive matter relating to British-made tractors, so that he may be in a position to deal readily with future inquiries.

Institution of Engineers and Shipbuilders in Scotland.—The following dates have been fixed for the meetings of this society:—1920: October 19, November 16, December 14; 1921: January 18, February 22, March 22, April 19. At the opening meeting on October 19, 1920, the president will deliver his address, and among the subjects to be submitted for discussion during the session are the following: "The Present Position of the Marine Diesel Engine," by Mr. James Richardson, B.Sc.; "The Relation between Sea Casualties and Loss of Life," by Sir Westcott S. Abell, K.B.E.; "Stability of Ships among Waves," by Mr. G. R. Edgar, B.Sc.; "Coal, Oil or Wind?" by Mr. C. O. Liljegren; "Modern Refrigeration," by Professor J. Wemyss Anderson, M.Eng.; "Pressure Flow Experiments on Nozzles," by Professor A. L. Mellanby, D.Sc., and Mr. William Kerr, A.R.T.C.; "The Dalmarnock Power Station," by Mr. R. B. Mitchell; "Gyroscopic Pendulums," by Professor J. G. Gray, D.Sc.; "A New Type of Low-Level Bridge," by Mr. John Galbraith. The "James Watt" anniversary dinner will be held in the Grosvenor Restaurant, Glasgow, on Friday evening, January 21, 1921.

NOTES FROM SOUTH YORKSHIRE.

SHEFFIELD, Wednesday.

Hull Coal Trade.—Expansions in virtually every direction are shown in the latest official figures relating to the Hull coal trade. Gross imports for September advanced 71,828 tons on the corresponding month in 1919 to 196,085 tons. For the nine months, the receipts totalled 1,698,604 tons, an increase of 205,746 tons on the comparable period of last year. Exports rose from 708 tons in September, 1919, to 41,243 tons last month, and to 291,112 tons for the last nine months as compared with 4,180 tons for the first nine months of 1919. The largest contributors last month were the Carlton, Grimethorpe and Frickley Collieries, with a joint total of 28,718 tons, this being more than double the quantity despatched in September, 1919. Large tonnages were also sent by the Bentley, Denaby and Cadeby Main, and Maltby Collieries.

Iron and Steel.—Despite the diminution of purchases by Continental users of engineering products, some big business is moving in the finished sections. One of the most notable features is in regard to armament construction, where, following an exceptional period of sterility, several large orders have been placed by foreign buyers which will provide some months' work for an increased number of operatives. Both the Japanese and the Dutch Governments have contracted for the supply from Sheffield of armour for the latest type of battleships, and negotiations are in progress for construction, for another foreign Power, of the most modern type of naval big guns. Benefit is also accruing from the far-sighted plans made by many of the largest steel firms for rolling-stock construction on a wider basis. Big orders have been booked by Cravens, Limited, of Darnall, and it is now reported that a contract worth over three quarters of a million sterling has been placed by the New Zealand Government with one of the three largest Sheffield firms for the supply of 2,500 railway wagons. Sheffield will find the bulk of the material, and construction will probably take place in Birmingham and Nottingham. In other sections, the easing off continues. One firm of steel makers has dispensed with the services of 1,200 men. In addition, over 500 operatives engaged by several manufacturers of automobiles and motor car materials have been released following the marked decline in purchases of special materials and machinery parts. The tool sections are sending away practically the whole of their output, though new business in files is less abundant. Conditions in regard to raw and semi-finished material purchases are moving more in favour of buyers. Following the drop of 2*l.* per ton in soft billets, the official quotations in acid steel have been marked down 1*l.* a ton. Bessemer acid now stand at 27*l.* 15*s.*, and Siemens acid at 28*l.* 5*s.* Foreign competition is confined to mild steels, and does not touch the production of special quality brands, but local prices are inevitably affected by movements and output in other competing districts.

South Yorkshire Coal Trade.—There is little prospect of changed conditions until the coal crisis is settled. Collieries are still being pressed by all classes of consumers, and in regard to house coal deliveries are compelled to pay greater attention to the needs of metropolitan consumers. Iron and steel makers could take a much bigger tonnage for reserve, gas companies have larger facilities for stocking than are being utilised, and railway companies, though well equipped for emergencies, have by no means exhausted their extensive storage accommodation. The only easier tendency is in regard to coke, in which large stocks have been acquired, and output is accumulating at ovens. Quotations:—Best branch handpicked, 37*s.* 2*d.* to 38*s.* 2*d.* Barnsley best Silkstone, 37*s.* 2*d.* to 37*s.* 8*d.*; Derbyshire best brights, 35*s.* 2*d.* to 36*s.* 2*d.*; Derbyshire house coal, 32*s.* 8*d.* to 33*s.* 2*d.*; Derbyshire best large nuts, 32*s.* 8*d.* to 33*s.* 8*d.*; Derbyshire small nuts, 31*s.* 8*d.* to 32*s.* 8*d.* Yorkshire hards, 32*s.* 8*d.* to 33*s.* 8*d.*; Derbyshire hards, 32*s.* 8*d.* to 33*s.* 8*d.*; rough slacks, 28*s.* 2*d.* to 29*s.* 2*d.*; nutty slacks, 27*s.* 2*d.* to 28*s.* 2*d.*; smalls, 23*s.* 2*d.* to 24*s.* 2*d.*

NOTES FROM THE SOUTH-WEST.

CARDIFF, Wednesday.

The Coal Trade.—The markets have undergone a complete change from the conditions of last week when coal of all grades was freely offered at comparatively low prices and export releases were readily granted. A week ago most collieries were badly in need of shipping in order to obtain a quick clearance of loaded wagons, but phenomenal activity on the freight market, at considerably increased rates, has resulted in a substantial improvement in the shipping position, for there are now 427 vessels in the South Wales docks, compared with 373 a week earlier. The activity displayed on the freight market will be realised from the fact that tonnage representing a carrying capacity of 465,000 tons was chartered during the week, of which 206 vessels of 413,000 tons were taken for Cardiff loading alone, as compared with 263 ships during the whole of September. Genoa options, for instance, took 35 vessels of 125,400 tons, at rates varying from 40*s.* to 50*s.*, against 25*s.* a week earlier, and Rouen 35 boats of 41,000 tons at 23*s.* 9*d.* to 32*s.* 6*d.*, against 19*s.* A large quantity of this shipping arrived over the week end, and as most collieries were fully sold for the current week prices are now as firm as they were easy, and it is practically impossible to obtain concessions. Collieries having got over their temporary difficulties in respect to wagons more stringency has been exercised with regard to export releases, which were previously freely granted irrespective of destination, according to the individual circumstances of collieries. For shipment this week prices are firm on the basis of 112*s.* 6*d.* to 115*s.* for large, against from 109*s.* a week ago, 100*s.* to 105*s.* for through compared with 90*s.* to 95*s.*, while best steam smalls are practically unobtainable, with ordinary sorts from 90*s.* to 95*s.* Foreign coal exports in the past week at 286,000 tons were the highest for any similar period in the past three months and 140,000 tons more than in the previous week. Of the shipments, 159,000 tons were supplied to France, 53,000 tons to Italy, 12,000 tons to South America, 9,000 tons to Spain, 3,000 tons to Portugal, 42,000 tons to British coaling stations, and 10,000 tons to other countries. The demand for coke is much in excess of the quantity available for export, and sellers have realised as much as 300*s.* for the small parcels they have for disposal. Pitwood is also in exceedingly short supply and with the demand pressing prices have hardened to 85*s.* Already a large number of ballot returns in connection with the datum line offer have been received, and these show an overwhelming majority against the acceptance of the Government offer. There is every likelihood of the full vote being adverse to the acceptance of the datum line. By such a result we should be thrown back to the position in the negotiations with the President of the Board of Trade when a deadlock was reached on the question of the 2*s.* wage demand. The suspension of strike notices terminates on Monday, but it is expected that a further suspension will take place and negotiations reopened on the wage demand.

NOTES FROM THE NORTH.

GLASGOW, Wednesday.

The Trade Position.—The general trade of the country has been seriously affected by the unsettled state of the labour world at the present time, and buyers all over are operating with much caution. This is the fateful week of the miners' ballot and the results from some of the districts are not encouraging, but until the final figures are published it is not possible to forecast the men's decision or their leader's action in the event of a "non-acceptance" vote. However, should the datum line proposal be rejected it is anticipated that another line of action will be tried in the endeavour to reach a settlement, but, failing that, a fight to the bitter end may take place. That would most certainly be disastrous to business, as so many industries would be affected. All round there is a quietness, not wholly attributable to the dispute in the coal trade, and the prospects for the latter part of this year and the spring of next year are not over bright. All buyers consider that top prices have been reached and that a fall is inevitable, owing to foreign competition for one thing, and they are unwilling to commit themselves to any extent at present and are only giving out hand-to-mouth orders.

Scotch Steel Trade.—The Scotch steel makers continue to be well employed with fairly good order books, but buyers are still holding off and fresh contracts are none too plentiful. For ship and boiler plates there is an excellent demand on account of the activity in the shipyards, but that outlet will not be so good in the near future because of the approaching dullness prophesied for the shipbuilding industry. Sectional material is generally quiet, and angles are particularly so. The reductions in the price of steel sheets has not brought out any phenomenal amount of new business, but the makers of black sheets have quite a lot of work already on hand, and their works are running steady. The lighter gauges are rather quiet, which is partly due to the easier tone in the galvanised departments. The shipping side of the steel trade in general has not yet opened out, but prices are still considered too high by the foreigner, although, were the material available and freights a bit easier a much larger business could be put through.

Malleable Iron Trade.—Active conditions are general in the West of Scotland malleable iron trade and a good demand exists from consumers. New bookings on home account have not been heavy of late, and old contracts are being gradually cleared off, and these are paving the way for export business increasing. The latter is still small owing to the heavy demands of local users, and also to the fact that friends abroad have been neglected for so long and have had to purchase elsewhere.

Scotch Pig-Iron Trade.—Little change of any note has taken place in the Scotch pig-iron trade and producers can easily dispose of their output to the home market. The amount of foundry and hematite iron has not increased and the scarcity of these is still very awkward to consumers. The export trade continues small and inquiries do not represent a large tonnage, and actual business is very small indeed. Prices are high and foreign buyers are looking forward to placing their business considerably under to-day's quotations.

PERSONAL.—The head offices of Messrs. Siemens Brothers and Co., Limited, and of Messrs. Siemens Brothers Dynamo Works, Limited, will be removed shortly from Palace-place Mansions, Kensington, London, W. 8, to Caxton House, Westminster, London, S.W. 1.

GREAT INCREASE OF FOREIGN SHIPPING AT STOCKHOLM.—We read in *Swedish Export* that the Customs authorities at Stockholm have petitioned the Customs Board for the appointment of 100 new customs guards and 4 new superintendents, owing to the fact that foreign shipping to Stockholm has so greatly increased. During the first five months of the present year, 667 vessels engaged in foreign trade arrived in Stockholm, of which 53 were large ocean-going boats trading with transatlantic ports. During the corresponding period of last year the total number of vessels arriving from abroad was 372, only 5 of which were engaged in ocean trade.

NOTICES OF MEETINGS.

THE BRADFORD ENGINEERING SOCIETY.—Monday, October 18, at 7.30 p.m., in the Engineering Lecture Room of the Bradford Technical College, Mr. J. E. Hills of Leeds, on "Water Supply and Well Boring," with lantern illustrations.

THE INSTITUTE OF TRANSPORT.—Monday, October 18, at 5.30 p.m., the First General Meeting will be held at the Institution of Civil Engineers, Great George-street, Westminster, London, S.W. 1.

THE INSTITUTION OF ENGINEERS AND SHIPBUILDERS IN SCOTLAND.—Tuesday, October 19, at 7.30 p.m., in the Rankine Hall. Presidential Address by Dr. T. Blackwood Murray. Paper to be read by Mr. James Richardson, B.Sc., on "The Present Position of the Marine Diesel Engine."

THE ROYAL AERONAUTICAL SOCIETY.—Thursday, October 21, at 5.30 p.m., at the Royal Society of Arts, John-street, Adelphi, London, W.C. 2. A paper by Squadron-Leader R. M. Hill on "A Comparison of the Flying Qualities of Single and Twin-Engined Aeroplanes," and another by Mr. Cecil Baker on "Night Flying," will be read in abstract and discussed. The chair will be taken by Major-General Sir W. S. Brancker K.C.B.

THE INSTITUTION OF PETROLEUM TECHNOLOGISTS.—Tuesday, October 19, at 5.30 p.m., Meeting at the House of the Royal Society of Arts, John-street, Adelphi, W.C. 2. The following paper will be read: "Coal as a Future Source of Oil Fuel Supply," by Sir Arthur McD. Duckham, K.C.B., M.Inst.C.E. The chair will be taken by the president, Sir Frederick W. Black, K.C.B.

THE JUNIOR INSTITUTION OF ENGINEERS.—Friday, October 22, at 8 p.m., at Caxton Hall; Ordinary Meeting; paper, "Impulse Turbines," by Mr. A. H. Fitt, A.M.I.Mech.E., Member. Slides.

THE INSTITUTION OF MECHANICAL ENGINEERS.—Friday, October 22, at 6 p.m., at the Institution, Storey's Gate, S.W. Presidential address by Captain H. Riall Sankey, C.B.

NOTES FROM CLEVELAND AND THE NORTHERN COUNTIES.

MIDDLESBROUGH, Wednesday.

The Cleveland Iron Trade.—The situation as regards Cleveland foundry pig-iron is slightly easier. Foundry qualities continue scarce, and No. 1 and No. 3 are still unpurchaseable for export, but indication is not wanting that the stringency will be less acute in the near future. The former is 237*s.* 6*d.* and the latter is 225*s.* for home purposes. Removal of the embargo on export of forge iron has just been announced. The fact that forge pig-iron is added to the list of commodities free for shipment abroad is, however, of little consequence as for quality is in little demand for abroad. Mottled and white pig-iron are very plentiful, but there is very little silicious iron to be had. To home buyers, No. 4 forge is 225*s.*, and that figure also rules for mottled and white; whilst silicious iron is quoted 255*s.*, and for export No. 4 forge is 247*s.* 6*d.*, mottled and white are 230*s.*, and silicious iron is 277*s.* 6*d.*

Hematite Iron.—Little now is ascertainable concerning the hematite branch. Though makers are well sold, iron is not so difficult to secure as it has been. Continental demand has fallen off considerably. Nos. 1, 2 and 3 East Coast brands are 260*s.* and upward for home consumption, 265*s.* and upward for shipment to France, Belgium and Italy, and 280*s.* and upward for export to other countries. No. 1 is quoted 2*s.* 6*d.* above mixed Nos.

Blastfurnacemen's Wages.—The average net selling price of No. 3 Cleveland pig-iron for the three months ending September 30 last has been certified at 217*s.* 6·31*d.*, and blast furnacemen's wages for the present quarter are advanced by 14 per cent., raising wages from 149·30 per ton above the standard to 163·50 per ton above the standard.

Foreign Ore.—Substantial inquiries for ore are in the market, and consumers are prepared to negotiate for supplies over the first half of next year. The ex-ship Tees value of rubio of 50 per cent. quality is now not less than 56*s.*, as the quotation is 50*s.* on the 17*s.* parity freight Bilbao-Middlesbrough, and the minimum figure now mentioned for charterings from the Spanish ore port is 23*s.*

Coke.—There is no longer ground for complaint as regards deliveries of coke to the local blast furnaces. Average furnace quality is 62*s.* 9*d.* at the ovens, and low phosphorus sort is 65*s.* 9*d.* at the ovens.

Manufactured Iron and Steel.—There is great dearth of new business in the finished iron and steel industries, but manufacturers are kept well employed on running contracts. By underselling, America and Belgium are capturing markets hitherto supplied by this district, and it would appear that producers here will have to reduce their quotations so as to continue to secure their fair share of orders in the world's markets. Common iron bars are 30*l.*; marked bars, 32*l.*; iron angles, 30*l.* 15*s.*; steel bars, 24*l.*; steel ship, bridge and tank plates, 24*l.* 10*s.*; steel angles, 24*l.*; steel boiler plates, 31*l.*; channels and flats, 24*l.* 5*s.*; rounds and squares, 26*l.*; soft steel billets, 23*l.* 10*s.*; hard steel billets, 25*l.* 10*s.*; heavy sections of steel rails, 25*l.*; fish plates, 30*l.*; corrugated galvanised sheets, 40*l.*; and black sheets, 35*l.*

PLOUGHING MACHINERY.

CONSTRUCTED BY MESSRS. JOHN FOWLER AND CO. (LEEDS), LIMITED, ENGINEERS, LEEDS.

(*For Description, see Page 507.*)

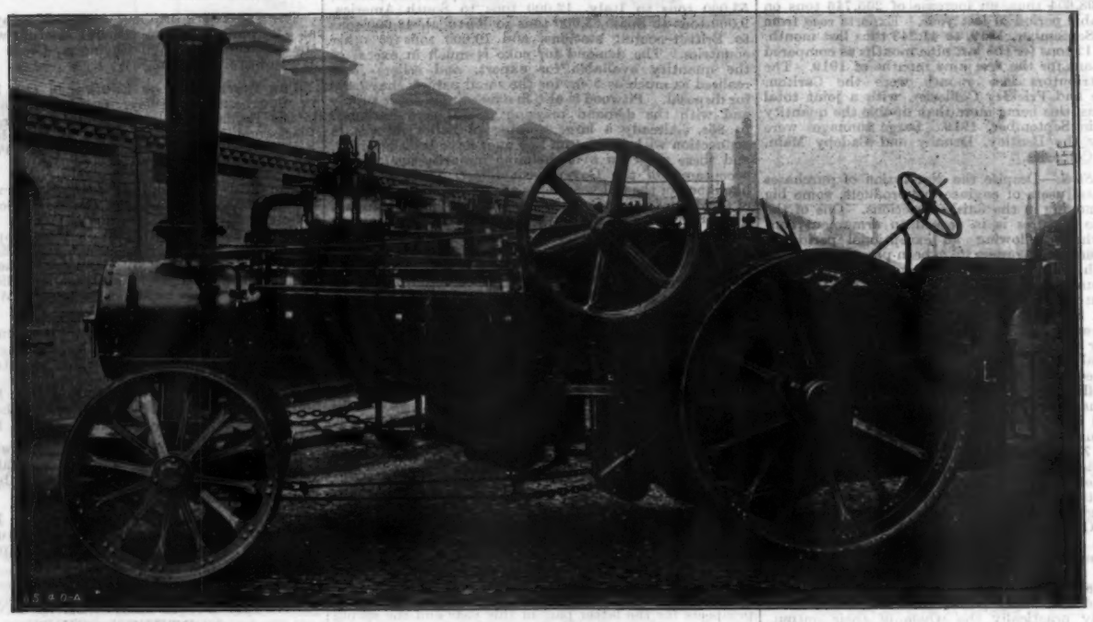


Fig. 1. 8-H.P. Superheater Steam Engine for Double-Engine Cable Ploughing.

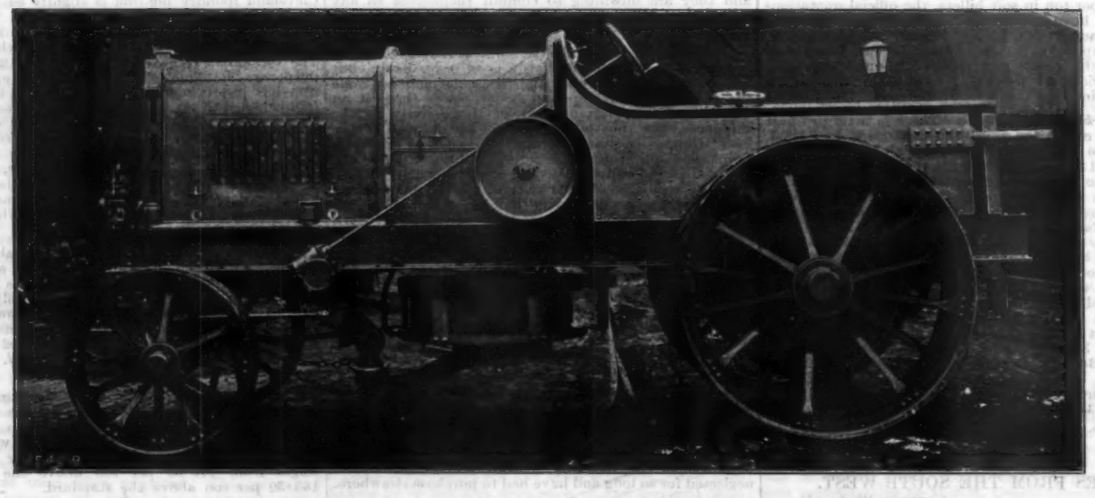


Fig. 2. 60-B.H.P. Internal-Combustion Hauling Engine for Double-Engine Cable Ploughing.

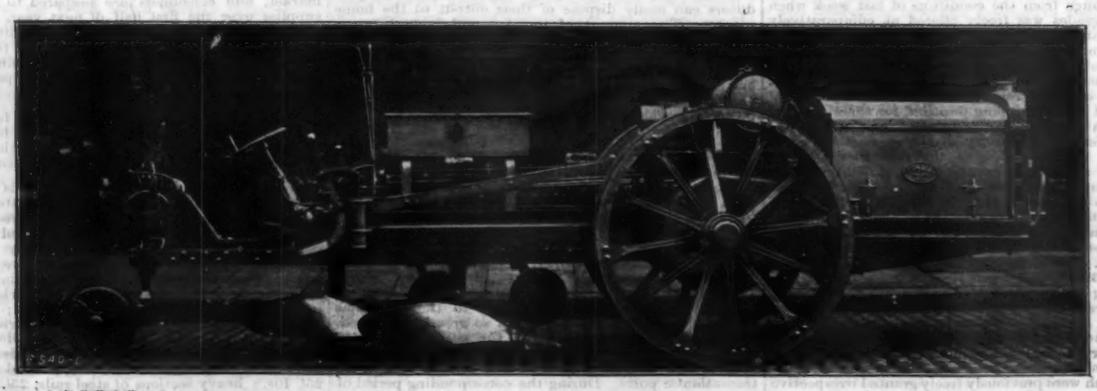


Fig. 3. 20-B.H.P. Self-Propelled Motor Plough.

REINFORCED CONCRETE PIT-HEAD FRAME AT BENTLEY COLLIERY, DONCASTER.

CONSTRUCTED BY THE YORKSHIRE HENNEBIQUE CONTRACTING COMPANY, LEEDS, TO THE DESIGNS OF MESSRS. L. G. MOUCHEL AND PARTNERS, LIMITED, LONDON.

(*For Description, see Page* 498.)

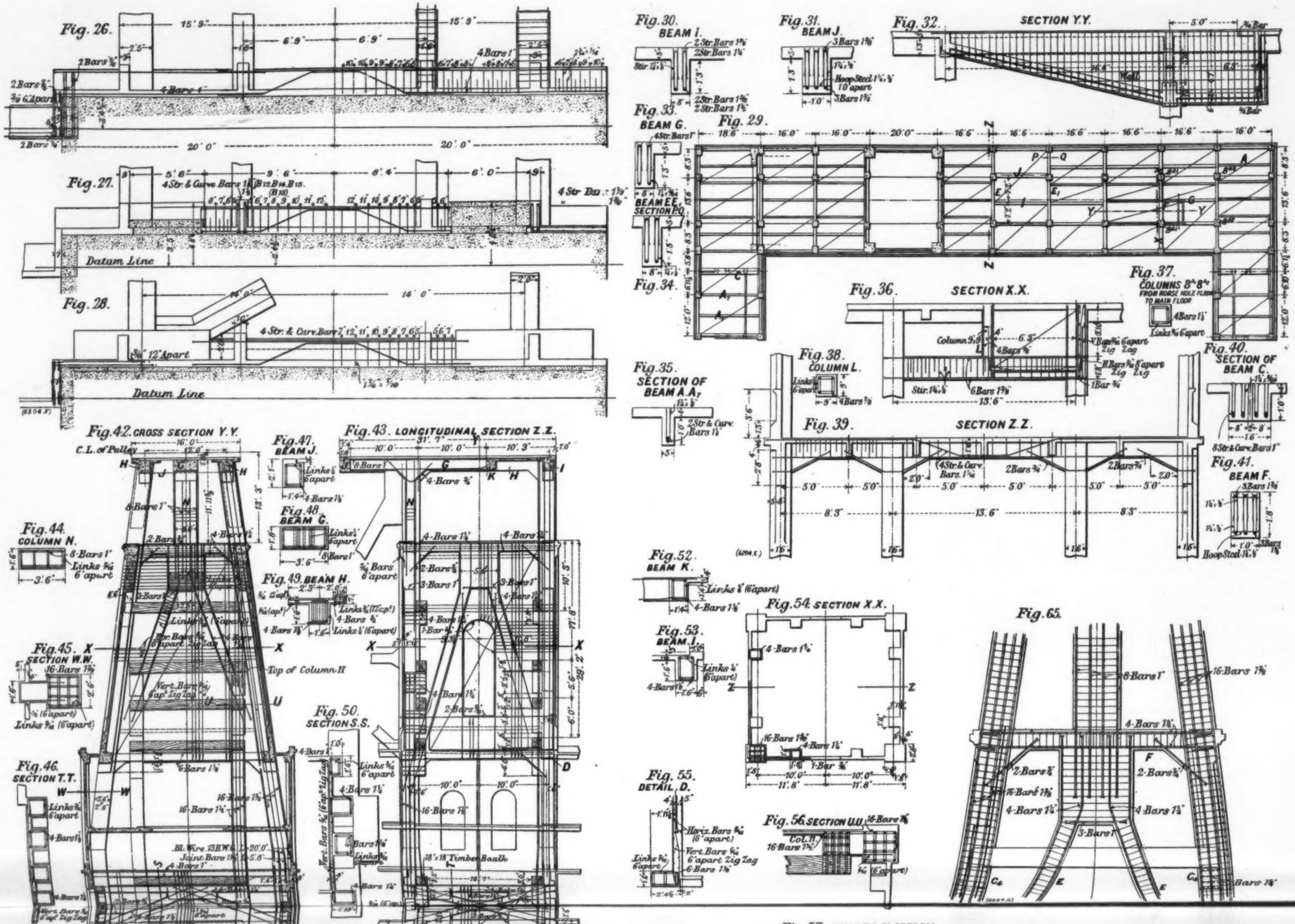
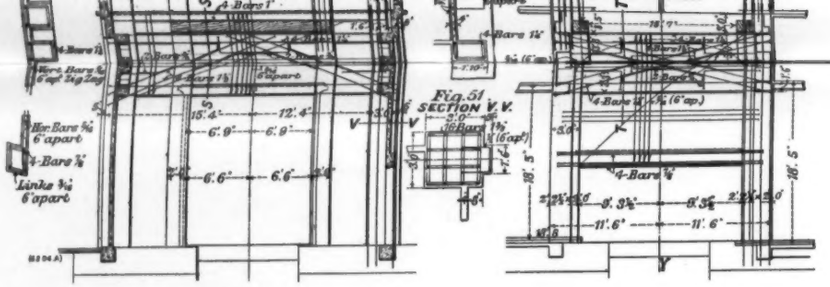


Fig. 57. PULLEY PLATFORM.



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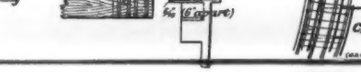
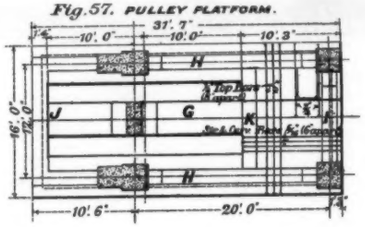


Fig. 57. PULLEY PLATFORM.



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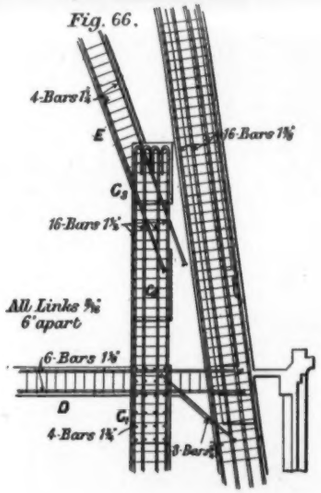

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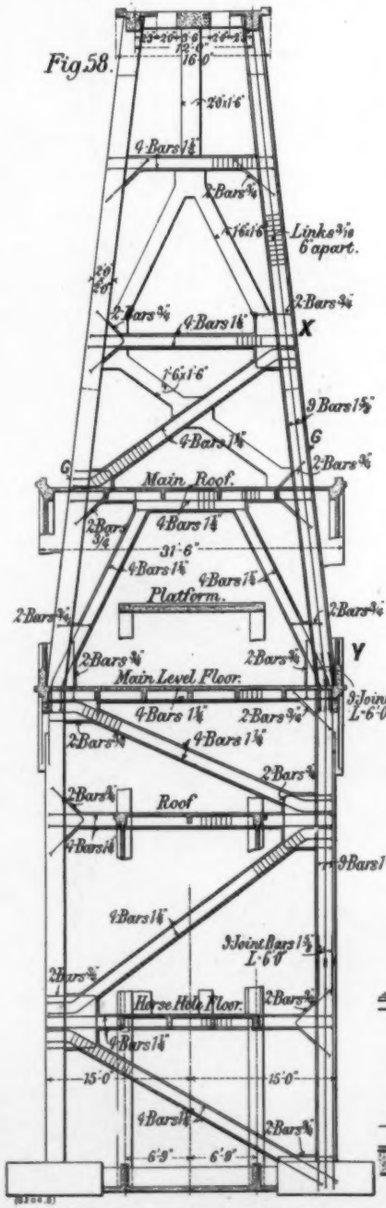

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Fig. 60.

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Fig. 61.

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Fig. 62.

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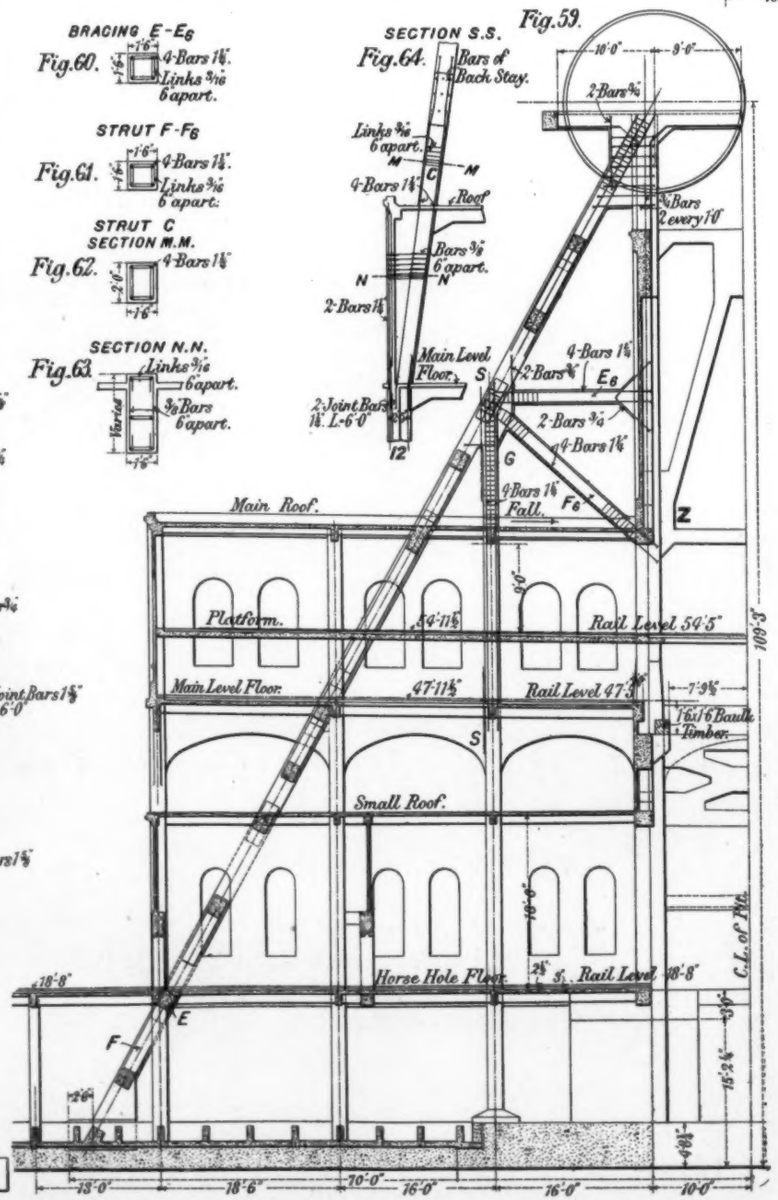
Fig. 63.

Fig. 59.



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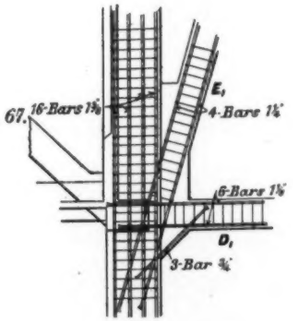

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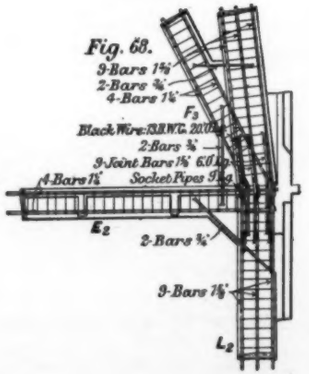

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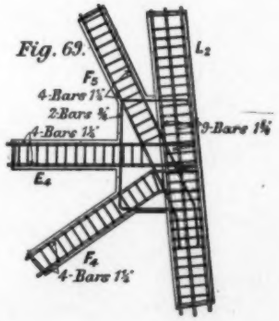

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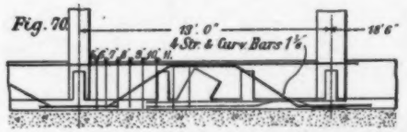

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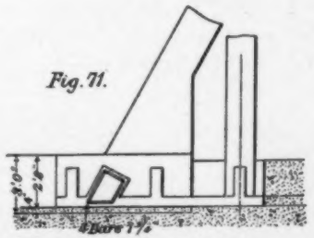

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Advertisements intended for insertion in the current week's issue must be delivered not later than First Post on Thursday. In consequence of the necessity for going to press early with a portion of the edition, alterations for standing advertisements should be received on the Friday previous to the day of publication.

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REVISED RATES.

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NOTICE.

A few months ago the Proprietors of "ENGINEERING" were compelled to advance the price of this Journal to 1s. per copy, owing to the enormous increases in the cost of paper, engravings and printing, &c. Now higher transport and delivery charges involve a further increase to 1s. 2d. per copy, and this price dated from and included the issue of Friday, April 2, 1920. As the postal rates have been again increased, the price of single copies sent by inland post is now 1s. 2½d.

NOTICE TO NON-SUBSCRIBERS.

In view of the restrictions still imposed by the Government on the importation of paper and the consequent shortage of supplies, Newsagents will not have copies for chance customers; therefore readers who wish to be sure of obtaining "ENGINEERING" each week should place an order for the Journal with a newsagent or bookstall clerk.

NOTICES OF MEETINGS.

Notices of Meetings to take place during the present and next week will be found on page 509.

ENGINEERING.

FRIDAY, OCTOBER 15, 1920.

PRODUCTION AND STANDARDISATION

APART from a few outstanding trades such as that of the typewriter, the sewing machine, and the bicycle few classes of engineering lend themselves so well perhaps to production in quantity as does motor car construction. It is no wonder, therefore, that Sir Henry Fowler, K.B.E., took the subject of production as the theme for his presidential address given, on Wednesday last, before the Institution of Automobile Engineers. This address, as Sir Henry himself admits, in its closing sentences is of "a somewhat rambling nature," and the apology thus offered rather disarms criticism. In the words of the author the address deals with many matters of great importance, many of them of sufficient importance for a whole address, and we venture to think that if the great energy and valuable experience possessed by our former Assistant Director-General of Aircraft Production had been concentrated on a few points instead of dissipated on the many, we might well have been enlightened by special information of more outstanding and permanent interest.

Production, indeed, covers a multitude of factors, and success is only possible by a nice adjustment of all of them. To-day we realise that there are involved not only questions of machinery and labour, but also of system and human relations. We may provide good machinery, but it is useless without the co-operation of labour. How to secure the latter, and make also for better management, are serious problems confronting our manufacturers to-day. We may be quite prepared to deal well by the shop-committees, and these may be found to be beneficial, but then may be brought up by the fact that a foreman, or a manager, has not quite the qualifications we should wish in some particular direction, possibly not connected with the technical side at all. Production will be correspondingly affected and it needs particularly nice judgment to decide the effect some mannerism or habit of a supervisor may have directly upon it. No one is ideal, and all sorts of men have to be dealt with, so that we can at best hope for a compromise. As the men act, and are judged, collectively, while supervisors are often isolated individuals the characteristics of the latter are brought into the greater prominence. At present our ideas are trying to re-arrange themselves after the war, and we have a long way to go before we shall arrive at any permanent solution of our many physiological problems connected with successful manufacture. It will be impossible ever to formulate rules for appraising character, and we shall always have to fall back on first finding an exceptional man to make the choice. The successful enterprises of the world have more often been built up by one strong man, either acting on his own account, or for a board, collecting an able executive around him, than by committees, since the latter, too often come to grief in balancing the factors of the compromise which ultimately proves to be necessary.

On the machinery side of the production problem too, nice points arise often as to what the best machinery is. In a recent article on machine tools we drew attention to development in this country and in the United States, as running towards the "universal" machine here, and the single purpose tool on the other side of the Atlantic. Sir Henry Fowler mentions in his address the interesting point, that when he visited the United States in 1918 with the object of procuring an early supply of a British aeronautical engine, he found this to be almost impracticable in nearly all of the large automobile works there, so specialised was their machinery, whereas the work could have been done in practically any British motor car factory. Here we come back to what is now known as mass production which has been so largely advertised in connection with automobile construction, though the successful bicycle and other trades have been run on these lines for many years. Mass production first requires a sound design, slightly ahead of the times, and the possibility of meeting an existing, or creating a large demand. Everything turns on the saleable quantity and without a basis of this kind to start on it is impossible to enter into estimates of the cost and output of special tools. The same point exactly, though in a somewhat different form, enters into every day shop work. How often are we confronted with the question as to whether a jig, or a new broach, or special form-milling cutter is warranted for so many pieces to be put through. The quantity production of the modern idea is simply an operation on a larger scale with something more of a hazard introduced as we cannot look into the future and make sure that nothing will arise to upset our calculations as to demand.

In passing it may be noted that special machines are not always complicated automatics. The single purpose machine is often a good deal simplified by the very fact that its work is limited in character. Additional movements are cut out, and we often get a cheaper machine than one of a more general utility. Then again we have to consider whether the machine will or will not be scrap by the time progress demands a revision of our standards. We have had plenty of examples in the past of good standardisation and of bad. Even the best design has a limited life. When introduced for mass production a standard must offer, if possible, two advantages. It must be cheap to manufacture, and must be such that purchasers feel they are getting something up to date. If a happy advance in some feature has been made sales will probably be further prolonged. The inability of automobile works in America to take up promptly the manufacture of an unusual product is interesting, though not a criticism to be necessarily levelled against them. Had the war not supervened such a demand would not have occurred and their normal production would have continued. It is not humanly possible to foresee all such contingencies just as firms in any branch laid out for large production have to face unpleasant slumps at home. It is doubtful if the ability to change over easily from one type of manufacture to another is ever warranted by the additional cost of normal production involved, and with the prospect of a few years normal running standardisation and special machines will almost certainly pay, and at the end of that time a revision of standards and also of the special machines is permissible.

Quantity production may, however, so absorb the imagination as to result in some curious anomalies. The extraordinary perspective in which standardisation is sometimes viewed was shown in the recent sales of motor transport vehicles. We believe we are correct in stating that at these high prices were paid often for well-known British makes of machines in bad condition while foreign makes in good condition only commanded extremely low figures simply because people thought spares would be readily obtainable for the one make and not for the other. Although cheap spares may have been procurable, the point seems to have been lost sight of that the final cost would have been far less for the foreign make, even including the cost of making

the required parts in small numbers at a relatively high price, and that such special manufacture may have been easily warranted in the overall transaction. Standardisation is a rather fickle subject, and its quest may often lead one astray. The somewhat narrow outlook of these purchasers who thought they were following commendable economic lines, probably on the broader issue were led to a considerable expenditure for comparatively little value.

REPORTS OF PATENT CASES.

For some time now the published reports of actions under the Patents, Designs and Trade Marks Acts have been shortened by omitting the abstracts of the evidence which used to appear. From an engineering standpoint this is a retrograde step, and the suggestion is made herein that the present practice might with advantage be modified. The reports in question form the supplement to the Official Journal of Patents, and appear at irregular intervals, there being about 20 in the year. In 1910 there were 32, but in 1918 there were only 14. They circulate not only among the legal profession, but indeed more largely among engineers, works, and so on, and the public libraries. That being so, although the legal result of the action is the most important point, together with the facts on which it was founded, it is instructive to those who examine reports to have all the technical, that is non-legal, data arising in the course of the proceedings available for reference.

In the more important patent actions, and indeed in practically every action for infringement of letters patent, evidence is given in support both of the plaintiff's case and of the defence by expert witnesses, probably two on each side, and by trade witnesses. The expert witnesses are men of science, usually of high standing, who know more or less generally the art in question, and who have taken care to instruct themselves minutely, by research, perhaps, and experiments, in the application of the art to the particular case forming the subject of the action. The trade witnesses are men skilled in the art to which the invention relates, and it is clear that the substance of the evidence given by these various parties from an engineering or scientific standpoint—and most patent applications relate to engineering or science—contains material useful to others in developing their work or in suggesting lines of research, or what is just as important, showing in what direction failure lies.

This can be better explained with reference to a specific case, and for consideration one may examine the report on an action relating to the welding of aluminium which has just been issued. With the merits of the case or the merits of the witnesses there is no need to deal here, because the argument is independent thereof, except that it can be brought out on the ground of certain statements made. After the case had been decided an application was made by counsel in respect of costs, and in furtherance of this, he stated that the plaintiffs had to make a large number of experiments. One of the witnesses made more than 400, and another made nearly 600 welds. The basis of the action, it may be mentioned, was the utility or otherwise of certain fluxes for welding the aluminium.

Now there is no indication in the report of the exact compositions that were tried in these experiments, which together totalled 1,000. It is true there are some general indications, but one cannot from the report say that such and such classes of flux with particular proportions will give good welds and others will not give good welds. Much of this information was given in Court, and, therefore, publicly during the hearing of the action, and although it would be impracticable to introduce details of even the major part of these experiments, yet a good deal could be learnt to that end if the evidence of the witnesses who made the experiments was reported to a reasonable extent.

Thus far the criticism has been destructive. From a constructive point of view the following may be said. The reports of patent cases open with a brief statement of the substance of the action, and then the chief features of the judgment. These features are important. Then follows the specification of the patent in full, or the salient features thereof. This, again, is important. After that there is a very full description of the pleadings, that is to say, the statement of the plaintiff's case, the defence, and the grounds on which the defence is based. Now, almost all patent actions have approximately the same grounds raised in these pleadings. Many of them are formal and need not, it is submitted, be specifically referred to, because one expects to find all available pleas raised in any action. One feature of the pleadings is important, and it is agreed should be reported as fully as possible, that is to say, the part of what are termed the "particulars of objections," which discloses the prior specifications and extracts from prior literature, with details of prior users of the invention on which the defendants rely in seeking to upset the patent. This is useful information. Counsels' speeches are abridged, and it is admitted that this is necessary. The judgment is given in full, which is obviously important.

On the other hand, according to present practice, as regards the evidence, the only reference thereto is contained in two paragraphs, one giving the names of those who appear in support of the plaintiff's case, and the other the names of those who appear on behalf of the defendants. The results of the evidence from the legal standpoint are summed up by counsel in the speeches, and to that extent are indicated in the report, but there is no basis given for this. The report usually ends with a good deal of discussion of minor matters relating to costs, suspension of injunctions, enquiries as to damages, and so on. If, therefore, a certain amount of this latter material were dealt with more shortly, and references to the pleadings were abridged, it would appear to be possible, whilst retaining the reduced size of the report, which presumably is necessary, to introduce again some details of the scientific evidence which it is thought would be of considerable interest to engineers.

THE COMMERCIAL MOTOR.

The Commercial Motor Exhibition which opens to the public to-day covers a very wide range. It is, in fact, difficult to say exactly what the limits of this range are, and it seems a pity that our English language has become so indefinite on certain points. An electric motor, for instance, is certainly a "motor," and is also commercial. The Diesel engine of a large ship is also called a marine "motor," and is also certainly commercial. Even if the word "motor" be used in the restricted sense of being synonomous with "motor vehicle" it is very difficult to define what is a commercial vehicle and what is a pleasure vehicle, for there is no particular reason why a taxicab or a char-a-banc out of which the owner gets his living should be considered a commercial vehicle any more than a large limousine out of which the owner also gets his living. Generally speaking, however, the definition of a "commercial motor" may be taken as being for the purpose of the show a self-propelled vehicle coming under the Light Locomotives Act but of any type which will not be shown at the Motor Show or the Motor Cycle Show. This covers a very wide field and a great variety of vehicles are shown. Thus there are vehicles for carrying goods ranging in size from small carriers for a few hundred-weight of parcels up to lorries carrying 5 tons to 6 tons. There are also agricultural tractors, taxicabs, baby traction engines, &c.

From the cursory view, which is all that it is possible to get up to the time of going to press, perhaps the most striking point is the very great diversity of practice which still obtains in the vehicles intended for carrying general goods. The commercial lorry was in use for a considerable time before the war. Further, during the war various types were used on a very large scale in such a way that a direct comparison of their various advantages and defects could be made by a very large number of people who have since in many cases returned to professional work in connection with the manufacture and use of motor vehicles. Under these circumstances it might have been thought that there would be a general agreement as to the best methods of construction, at all events as regards the principal features. This, however, does not appear so far to be the case.

There are, for instance, a considerable number both of steam and petrol-driven vehicles. In the case of the steam lorries some makers pin their faith to traction engine practice, the boiler being of the locomotive type with the engine on the top, others place the engine underneath the vehicle and use a vertical boiler, generally some form of water-tube design. Central pivot steering is employed by some builders; Ackerman steering by others. Some engines are compound, some simple, and there are representatives of slide valves, piston valves and poppet valves.

In the case of the petrol lorry there is also a considerable diversity. Frames are of channel steel, pressed steel and wood steel-plated. There are chain-driven lorries, live axle lorries, and lorries with the back wheels driven by pinion and internal gear wheel. Of the live axle vehicles some have double-reduction gear, others worm drive. In minor points there is also still a very great diversity of opinion. It appears, therefore, that there is still a field for varied forms of construction for different purposes, and further that in many cases the different forms give results so nearly equal that there is as yet no definite conclusion as to which is the best.

Perhaps the most striking novel feature is the fitting of a considerable proportion of the heavy vehicles with pneumatic in place of solid rubber tyres. There are several instances of this, the tyres being of truly enormous diameter, nominally 10 in. A move in the same direction is that the small traction engines built to come under the Motor Car Act are now being put on rubber tyres in place of steel.

For all ordinary work the petrol vehicle is now practically always fitted with a four-cylinder engine, the single and double cylinder having become obsolete. There is at least one example of a six-cylinder lorry chassis. Electric self-starters are being provided for the heavy vehicles in some cases. Special attention is now being paid to the convenient handling of goods, an instance of this being the tipping bodies. These were formerly tipped by a screw gear actuated by hand, but there are several examples of the engine power of the vehicles being used for the purpose, whereby considerable saving of time and fatigue is effected. We shall deal with the exhibition at greater length next week.

THE AIR CONFERENCE.

The proceedings at the Air Conference called by the Air Ministry for the purpose of discussing technical and economic problems connected with aviation opened on Tuesday morning last, at the Guildhall, London, when the members were welcomed by the Lord Mayor, Sir Edward Cooper. Sir Edward reminded the members that on the outbreak of war we were not prepared in the matter of aviation, but that at the end of the conflict we had attained the leading position. He hoped the deliberations of the conference would help to make a similar advance in civil aviation. It must be remembered, Sir Edward continued, that we could no longer regard ourselves as an island nation and we could not now rely entirely upon our Navy for defence, but if aviation progressed as it had begun he thought we might be tolerably safe as to the future.

Civil Aviation and Air Services.

The Lord Mayor then asked Lord Montagu of Beaulieu to take his position in the chair, and after doing so Lord Montagu called upon Major-General Sir F. H. Sykes, the Controller-General of Civil Aviation to read his paper entitled "Civil Aviation and Air Services." This paper we reprint, with slight abbreviations, on page 524 of this issue so that we may at once proceed to the discussion.

The first speaker, Sir W. Joynson Hicks, Bart., M.P., after congratulating Major-General Sykes on his paper, said the latter left but little room for criticism. He concurred with the author's view that in a few years' time civil and military aviation would tend to diverge. Entirely different types of machines were required for the two Services. In the former weight-carrying was of primary importance, and there was no place for the fast scout although such machines were essential for military

work. The speaker thought that, in war time, civil aviation would almost entirely cease, since all available pilots would be required for military duties. With regard to subsidies he suggested that these should be of an individual character to pilots, and said he would like to see all pilots required to pass tests as to health and performance for the purpose of acquiring a reserve of pilots for the military side of aviation. The author had referred to the carriage of mails as the basis of civil aviation, and he, the speaker, would like to see the whole of the British mails to the Continent carried by way of the air. He thought the Postmaster-General might well apply for definite tenders to this end, and if the United States could attain an efficiency of 94 per cent. in the carriage of mails, we should in this country be able to reach an efficiency of 100 per cent. The progress of civil aviation in the matter of passenger carrying, the speaker thought, was very encouraging, and he noticed that the number of passengers had increased more rapidly than the number of flights. The weight of goods carried, he also pointed out, had increased by over 500 per cent. in the period considered in the paper. These facts, he thought, indicated appreciation on the part of the public. Major-General Sykes' department had assisted civil aviation by instituting prizes which had just been competed for at Martlesham and Felixstowe, and this was an excellent form of subsidy. Trial orders had also been given, and he thought it right that the department should provide aerodromes. The speaker, however, was not in agreement with the view expressed by the author that power should be given to local authorities to provide aerodromes; it was better that these should be provided either by private enterprise or by a central authority. In the matters of meteorology, wireless telegraphy and the provision of lighthouses, the State had helped and should continue to assist in the future, and they might also assist by encouraging the provision of a fuel cheaper than petrol. He did not, however, think it desirable to ask for a direct State subsidy for civil aviation, and he also wished to utter a word of warning with regard to the central focus of Imperial flying services. What, he asked, would be the position when Egypt was no longer a territory of the British Empire. The aerodromes and organisation would then have to be moved, and that was a very serious matter. When Egypt returned to national control it would, the speaker thought, be a matter of vital importance to retain as British territory an amount of land sufficient for the purposes of aerodromes to be used as a centre for aviation service.

The next speaker, Lieut.-Colonel Moore-Brabazon, M.P., said the author had touched upon the subject of meteorology, to which subject he, the speaker, would confine his remarks. Meteorology, although of use to everybody, was a much neglected subject. To him it seemed farcical that it was possible to predict the exact moment of an eclipse of the moon many years in advance of the event, while it was not possible to say with certainty in the morning whether or not it would rain in the afternoon. Now that the science of aviation had advanced so rapidly it would be possible to obtain meteorological readings in the air, and some of the existing problems might be solved in this way. It should be possible not only to predict the weather some time in advance but also to control it to a certain extent. It might be possible to send up an aeroplane to stop a thunderstorm, and in countries like certain parts of South America, where clouds rolled up every evening during periods of drought, it would be possible to bring about precipitation. Meteorology, the speaker considered, was a backward science, and aviation ought to help it along.

Sir Alan G. Anderson, who followed, thanked the author of the paper, but thought it would interest the members to hear how aviation appealed to him and other shipowners. He thought that a paper on civil aviation should not neglect lighter-than-air craft, since these were admittedly more suitable for long-distance journeys than aeroplanes were. He also thought the picture drawn of the efforts of the Civil Aviation Department, both interesting and commendable, but it was hardly good enough from a commercial point of view. The primary necessity was to make the movement pay. With regard to the future separation of civil and military aviation he thought this undesirable. In general a State which achieved greatness in warfare was also great in commerce, and the State that made aerial transport pay would obtain the command of the air in war. We ought to be that State, but the paper did not explain how it was to be done. He would like to add a word on the subject of airships. Airships might or might not be a commercial proposition; at present it was not possible to say as they had not yet been tried out. It could be said, however, that there were possibilities of revolutionising overseas transport by their use. For instance, the voyage between South Africa and Australia could be completed in about 72 hours in an airship travelling at 50 knots, and he thought that a great mercantile nation like ours should not allow such possibilities to be taken up by other countries. He was, however, only speaking his own views, but he thought other shipowners ought to be interested. If aviation could be proved likely to pay there would be no difficulty in obtaining financial support.

The next speaker was Mr. Holt Thomas, who said that Sir W. Joynson Hicks had covered his main point. He hoped the Government would support the Air Department in their efforts to foster civil aviation. It was essential for this country to be first in the air, and he hoped the Conference would show how this was to be brought about. With regard to the carriage of mails, he thought this of little use in England, but the case of the mails to the Continent was different. If all the Continental mails were forwarded by air, the charge would be infinitesimal. For a surcharge of a halfpenny per letter the service could be made to pay, and this would prove a great advantage to civil aviation. Subsidies, he said, were not required, but what was needed was payment for services rendered. If Great Britain decided to adopt aerial mails every Dominion would follow suit and air lines would be inaugurated all over the world. It would be quite possible to carry all first-class mail matter to the Continent in the time now taken to transmit a telegram, and at a charge above the existing postal rates of not more than that previously mentioned.

Mr. S. Instone said that, as a shipowner, he had taken up civil aviation to see what could be done, but after 12 months' experience he could only say that, financially, it was a failure. The London to Paris service, he said, could not pay if every machine were fully loaded, if depreciation, &c., were properly allowed for. It would, however, be a lasting shame if civil aviation were compelled to close down, and it was necessary for the Government to put British firms in a position to compete with Continental firms. The Government, the speaker continued, had to build ships and keep them in commission in order to train the *personnel*, and he suggested that they should construct aeroplanes for the same purpose; or an allowance might be made to each machine built and employed in civil aviation, the sum being allocated for upkeep and pilot's salary, on the condition that both should be taken over by the Government in time of war. Transport companies should also have free use of aerodromes and hangars, since these would always have to be built for service requirements. In the matter of insurance also, the Government should arrange to insure all commercial aircraft at a premium which would not result in a loss but which would not produce a profit. Although, the speaker continued, commercial aviation had been a failure so far, his firm did not intend to discontinue. At the same time no new business could attract capital unless it could show a profit. The Government, he said, must help, and though he fully appreciated what had been done so far, more assistance was essential, since it could not be expected that the burden should be borne entirely by a few individuals.

The next speaker, Mr. R. Bruce, said the aircraft industry had fallen from a position of affluence to an almost dying condition. Most speakers had regarded direct subsidies as ineffective, but he considered the present indirect assistance as too remote. With a commercial aviation industry in being there would be a constructional industry, but he asked what was to happen in the meantime? It was, he said, nearly 18 months since the process of disintegration in the industry had commenced, and although some decline had been anticipated, he thought it had now gone too far. Subsidies, he agreed, were bad, but there were other ways of helping the industry. In particular, the speaker thought the Government should prevent the further disintegration of technical staffs, without which machines could not be produced. He suggested that a number of firms should be selected which were capable of designing and constructing aircraft, and each given a definite project, such as the design, construction and development of a certain type of machine. Something of this nature he regarded as essential for carrying on the industry.

After a few remarks by Mr. Lord, of Messrs. A. V. Roe & Co., in which he pointed out that something must be done to prevent the few remaining designing firms from going out of existence, Sir Charles Bright spoke on the matter of subsidies. Sir Charles said he could not understand why subsidies were regarded as bad in connection with civil aviation when they had proved quite satisfactory in the case of telegraph cables. In the latter connection the country had received a good return on its expenditure, and he thought the same would be the case with civil aviation. Mr. L. Blin Desbleds read a written contribution to the discussion, in which he stated that the Conference was a proof of official activity trying to arouse and develop public interest in aviation. He pointed out that, at the termination of hostilities, Great Britain was far ahead of any other nation in the matter of aeronautical technology and practice, but he feared that lead had not been maintained. We could not afford to allow aerial transport to take care of itself, and in its own interest the business world should realise that its immediate future was vitally linked with the development of commercial aviation. He suggested that the Controller of Civil Aviation should send out qualified representatives to advise local authorities on the creation and working of local air routes, and expressed the view that our long distance Imperial commercial air routes should be formed by linking up a large number of sound local undertakings rather than by being created in one step.

The discussion was continued by Mr. A. E. Berriman, who referred to financial matters and pointed out that the capital cost of the existing services was in no case less than 1,000*l.* per passenger seat. Running costs were never less than 600*l.* per seat per annum, or 2*l.* a day for each seat, assuming that the machines flew 300 days a year. With a further 2*l.* a seat for working expenses, the minimum possible fare for the London to Paris journey would thus amount to 4*l.* This assumed that all machines flew on every flying day, and that all seats were booked, which was, of course, impossible. If, however, as had been stated, there were two machines on the ground for each machine in the air the minimum fare became 12*l.*, and, if all the seats were not booked, the latter figure had to be raised accordingly. The present actual fare of 10*l.* had been based on the assumption that half the number of machines were in the air and half kept in reserve. The speaker felt that the Government would have to provide some kind of subsidy, and the best subsidy would be some form of guaranteed load not, however, necessarily of mails. What was required, he said, was a guarantee that a fixed proportion of the carrying capacity would be filled.

Major General Brancker, who followed, said he was against subsidies traditionally, but he had been reluctantly compelled to consider them necessary. Commercial aviation, he thought, would soon pay now, but capital was required to replace obsolete aircraft with new machines. If this were done, it could be made to pay in a year or so, but some Government assistance was now needed to help firms out of their present difficulties. The speaker did not regard it as altogether desirable for military and civil aviation to be under the same ministry, as there was a possibility of the latter being neglected. If aerial transport had been under the control of the Ministry of Transport, he thought the present position might have been very different. In addition to providing a guaranteed load he

thought the government might improve the meteorological service on the London to Paris route, and he also suggested that they might prepare an estimate of the cost of an aerodrome to be erected over Victoria Station. At present considerable time was wasted by passengers in getting to and from the aerodrome, and although his suggestion, perhaps, seemed far from practicable, something of this kind might eventually be done.

Mr. Lawrence Wingfield, who referred to methods outside aviation by which the revenue of aerial transport companies might be increased, was followed by Mr. R. H. Hooker, who dealt with meteorological matters. Mr. Hooker referred to the point raised by Sir Alan Anderson in connection with an airship flight from South Africa to Australia. It was, the speaker pointed out, quite possible that this journey could be accomplished in 72 hours with the assistance of the prevailing winds, but he asked how long the return journey against the wind would take. The only other speaker was Mr. J. Westaway, who said he was interested in a type of machine in which a vertical lift could be obtained. He was pleased to note that Major-General Sykes had referred in his paper to the possibilities of this type of aircraft. He regretted that time did not permit him to explain his system.

This concluded the discussion, and after the Chairman had thanked the author for his paper the morning session terminated.

The Operation of Civil Aircraft.

The paper read and discussed in the afternoon session was one by Mr. H. White-Smith, the Chairman of the Society of British Aircraft Constructors, Limited, the paper being entitled "The Operation of Civil Aircraft in Relation to the Constructor." The paper deals with aircraft of the heavier-than-air type, including both aeroplanes and seaplanes, from the business or commercial point of view, apart from technical questions. It first discusses the reasons for the present lack of financial success in operating air services, citing as the main causes the fact that the public has not yet acquired the habit of travelling by air, and still doubts the reliability of the services. High fares and freight rates and lack of comfort for passengers and facilities for luggage, are regarded as contributory causes. Means for improving the attitude of the public towards commercial aviation are dealt with, as also are methods for improving the safety and reliability of the services. In the latter connection the need for research to facilitate landing in fogs and for improving the conditions of night-flying are emphasised.

An important part of the paper is a tabulated statement of the capital and operating costs of a hypothetical service between London and Paris, with six machines each, of 13 different types. The cost per passenger and per pound of cargo is calculated for different load factors, the former ranging from 7*l.* 4*s.* to 18*l.* 10*s.* 6*d.* for the single journey with a 75 per cent. load factor. At the same load factor the cost per pound of cargo ranges from 7*d.* to 1*s.* 5*d.*, and it is interesting to note that the lowest figure in each case is achieved with the "Airco 18" machine illustrated and described on page 238 *ante*. The figures are estimated and not actual working results, and the comparisons, therefore, may not be strictly accurate. They serve, however, to indicate to constructors the lines on which it is possible to improve designs with the object of reducing operating costs.

After discussing the requirements of commercial machines for passenger work and for the transport of light and heavy goods, respectively, the author turns to the subject of seaplanes and amphibious aeroplanes, and calls attention to the somewhat striking fact that machines of this class are not yet used for commercial work in the British Isles. Capital and operating costs for a service similar to that above referred to, but employing seaplanes and amphibians, are then given in tabular form and discussed. The costs are worked out for six different machines, and we notice that the cost per passenger for a similar journey to that above quoted for land machines, ranges, in the case of seaplanes and amphibians, from 16*l.* 11*s.* 6*d.* to 30*l.*, while the cost per pound of cargo varies from 1*s.* 5½*d.* to 2*s.* 9*d.* The costs here quoted are calculated for a 75 per cent. load factor in each case. The higher costs, in comparison with land machines, are, of course, due mainly to the lower speed for a given horse-power of craft designed to alight on water.

Dealing with the question of aircraft engines the author considers that, although great advances have been made in the last five years, there is still need for improvement in the matter of reliability, and suggests that it may be desirable to increase the weight per horse-power in order to improve this feature. He also urges the necessity for increased fuel economy, and for the discovery of a much cheaper fuel as a substitute for petrol, pointing out that the present expenditure on that fuel represents the largest individual item in the running costs, and is equivalent to about one-third of the total operating charges. The remainder of the paper is devoted to the questions of maintenance of aircraft and engines in service, and to the special requirements and opportunities for aircraft in foreign countries. In conclusion the author views the future of commercial aviation hopefully, and considers that although financial success may not yet have been achieved it is not far off. The figures given he regards as pointing clearly to the necessity for continued technical progress, and he urges on the Air Ministry the need for the placing of orders for experimental machines so that firms of aircraft constructors may keep their design staffs in being.

When Mr. White Smith had finished reading his paper, the chairman, Lord Montagu, called upon Lord Weir of Eastwood to open the discussion. Lord Weir said the paper appeared to him to be both straightforward and useful. It dealt with facts and gave data, which in conjunction with Major-Gen. Sykes' paper, showed the true position of civil aviation at the present time. The object of the Conference, he said, was to enlighten the community and the Government on the importance of sound progress in aviation. Both were apparently apathetic to a development which appeared to be slow and unsatisfactory, but more had been done than was generally realised. It was, he thought, difficult to bring home the responsibility to the Government. Final success depended upon private enterprise and would be achieved by capital and the community as a whole. No Government could compel prosperity to civil aviation. It was necessary for the public to convince themselves by actual trial that the air services were realities offering new facilities for travel at a cost which was worth while. Referring to the cross-Channel services, Lord Weir said these were of unique importance, and it was better to maintain and expand these than to embark on new schemes. With regard to the question of direct aid from the Government, the author had indicated in his paper that with the most fully-developed air service of to-day, having a load factor of 75 per cent., the total costs about balanced the takings. The speaker hoped, however, that before the close of the Conference it would be shown that Mr. White Smith's estimates of cost were unduly high, but the Conference must show the Government that the services were of such vital importance as to warrant direct financial support. This country possessed the best pilots and designers, and had carried out all the pioneer flights of the world, and the cross-Channel services had a definite claim on the Government to see them through their early difficulties. He thought their claim for help could not be disregarded much longer, and suggested that if the Conference did no more than pass a resolution justifying the line of action recommended by his, the speaker's, Committee, it would be the greatest thing yet achieved in aviation.

Mr. F. Handley Page, the next speaker, thought Mr. White Smith had rather over-estimated the drawbacks of air travel, which actually had many advantages over other methods of transport. He explained these advantages, and also pointed out that aircraft were in the process of development and that the future would see improvements corresponding to those which followed the introduction of railways, steamships and motor cars. With regard to the aerial transport of mails, the speaker thought it much easier to persuade one passenger to travel by aeroplane than to obtain an equal load by inducing, say, 5,000 people to send letters by air post; but if the use of the air mail was made compulsory, it would be quite a different matter. Referring to the figures for running costs given in the paper, the speaker said the author had calculated the cost per passenger to Paris in one of the Handley-Page O–400 machines at 11*l.* 8*s.*, with a load factor of 75 per cent., but as the company only received a 10*l.* 10*s.* fare, that would not be a business proposition. The cost per flying hour given in the paper as 22*l.* 9*s.* was actually 16*l.* 17*s.*, and this reduced the cost of a passenger journey sufficiently to allow a margin of profit. Other figures, the speaker said, might also be challenged. With regard to depreciation of machines, the speaker said an allowance must be made for this, which depended on the flying hours per machine. It was better to write machines off quickly and replace them than to store them up until they became obsolete, and for this reason subsidies were necessary. The subsidy proposed on the basis of 25 per cent. of the gross receipts of transport companies, the speaker pointed out, would not be a large sum, and it would, in fact, be just about the same as the Government had saved by withholding some of the prizes at the recent competition. In conclusion, the speaker remarked that the few machines employed to-day in civil aviation resembled the number of service machines employed at the beginning of the war, and he hoped to see the commercial air fleet grow as rapidly as the number of service machines had increased during the war.

Col. F. Searle, D.S.O., who followed, said the author had referred to the lack of financial success of air services, and this, he thought, would have been obvious had more careful preliminary investigations been made. It was not possible to achieve success with two-seater or four-seater machines. With regard to the high fares charged, the speaker pointed out that aerial transport companies catered for business men for whom the time saved by air travel was more than sufficient to compensate for the high rates. There was also a considerable saving in hotel expenses, and this should be taken into account. The question of safety, the speaker continued, was one of vital importance, since accidents had a bad effect on the industry in general. In this matter the Air Ministry might step in by requiring all civil aviation pilots to obtain some navigation certificate. At present, the speaker stated, some 90 per cent. of pilots flew by eye only, whereas if they flew by navigating instruments there would be less risk of accident. Arrangements for navigating by wireless were also in need of improvement, as wireless provided the only means available for completing a journey in really bad weather. The speaker also touched upon the questions of night flying, turn indicators, aneroids and other instruments, and stated that the life of an aeroplane engine given in the paper as 3,000 hours was much too low. The London motor omnibus engines, he pointed out, ran some 3,000 hours per annum, and some had been in use for 10 years with ordinary maintenance. With regard to the earning powers of machines, the speaker thought the author had been unduly pessimistic. The Airco 18, he stated, cost about 5,000*l.*, and at a fare of 10*l.* 10*s.* per passenger earned 160*l.* in five hours. This represented a profit of 100*l.* a day, and actually a machine should be able to fly for a much longer period than five hours. The speaker also referred to constructional details of machines and pointed out several ways in which these might be improved, mentioning that rubber connections in the petrol system should be avoided and control cables might with advantage be replaced by some device less liable to wear. He also pointed out the desirability of providing machines with double cockpits for the purpose of training new pilots.

The next contribution to the discussion was by Mr. H. Sleeman, of Aerial Transport, Limited, Melbourne, who read his remarks somewhat rapidly. Referring to the operating costs given in the paper, he thought the basis of comparison was wrong, and said it should have been made by estimating the amount of cargo handled. Estimated in this way the cost per pound of cargo for the 240-mile journey came out at 6.2*d.* for the Handley-Page W 8 machine, 6.7*d.* for the Vimy and 5.5*d.*

for the Martinsyde; whereas the author's figures for a 75 per cent. load factor were 7½d., 11½d. and 8½d. respectively. The question of range had not been considered in the author's calculations, and this was an important point for overseas users, since they had to deal with longer distances and the cost of fuel was higher. The working capital which the author had taken as equal to this month's running costs, the speaker thought, should have taken as four months. He also referred to the shipping of aircraft and spares overseas, and with regard to the latter expressed the view that it would be found necessary to manufacture these in remote countries rather than to ship them from England.

Lieut.-Col. E. Van Dawson, who followed, said he thought that much of the lack of success might be attributable to imperfect appreciation of the position to-day. Aviation enthusiasts, he said, had rather tried to impose commercial aviation on the public, whereas the pressure should come from the other side. Attempts had been made to link up towns without consulting the inhabitants, who were really the best guides, as they would use the lines afterwards. In some cases quite short routes would pay, whereas longer ones would not. The solution, he thought, was to be found by educating the public, and he suggested that it might be useful to fit out expeditions including several types of machines and send them out to demonstrate in different parts of the Empire. Such expeditions would also clear up some of the points raised in the paper as to the requirements of machines for use in tropical countries.

At this stage of the proceedings the Chairman read the following resolution handed in by Mr. Holt Thomas: "That this Conference calls on the Government to decide definitely that all first-class mail matter shall be sent by air mail on selected mail routes of importance"; after Mr. Holt Thomas had spoken to the resolution and it had been seconded by Major-General Brancker, it was put to the meeting and carried unanimously.

Mr. A. E. Berriman also spoke on the paper, referring to some errors in the table of costs accompanying it, and at the conclusion of his remarks the proceedings terminated for the day with a vote of thanks to the Chairman, proposed by Mr. White Smith.

The following day was occupied by the reading and discussion of papers of a technical nature and by a visit to the terminal aerodrome at Croydon, and on Thursday papers dealing with service aviation and airships were read and discussed; but we must defer an account of these proceedings to our next issue.

(To be continued.)

NOTES.

Oil Fuel at Sea.

The annual report of Lloyds' Register just published, shows that oil fuel is steadily making its way at sea. No less than 426 of the vessels classed during the past year are fitted for burning oil fuel, whilst a large number of existing steamers are being converted to the new system. As matters stand, 76 per cent. of the vessels classed by Lloyds use coal, 16·3 per cent. use oil for raising steam, and 1·7 per cent. only have internal-combustion engines. The use of the latter has, however, increased greatly since the armistice, and during the year covered by the report, 28 new vessels were fitted with main propelling engines of this type, the aggregate tonnage being 79,805. More than 150 sets of Diesel marine engines are now being built under Lloyds survey, and about as many more of other patterns of oil engine. About one-half of these are under construction within the United Kingdom. The largest of the Diesel engines now being built under survey is intended for the ss. Glenogle, a twin-screw vessel of 9,150 tons. The engines will have 16 cylinders, 29·1 in. in diameter by 45½ in. stroke. Considerable modifications are being made, the report states, both in Diesel and other oil engines. The plan of injecting the fuel in to the cylinder without the aid of compressed air, which was so successfully adopted in submarine practice, is now being applied to surface craft. With regard to other types of oil engine the most notable change lies in the direction of using higher maximum cylinder pressures, which in some cases are now as much as 550 lb. per square inch. So far as steam practice is concerned, it is of interest to note that the geared turbine has been adopted for about one-third of the total tonnage classed during the year.

The Baltic Cable Leba–Königsberg.

The former Prussian province of East Prussia, reduced in size, now practically forms an enclave in Poland and is entirely cut off from the main portion of Prussia. In order to maintain the connection a cable has been laid in the Baltic from Leba, in the eastern part of Pommerania, to Tenkitten, near Königsberg, in East Prussia. With its length of 160 km. (100 miles) the cable is one of the longest, if not the longest, marine telephone cable in existence, and it is also remarkable for the number of telegraph and telephone lines it encloses. The six double (loop) conductors and three single conductors can be coupled so as to furnish six telegraph circuits and nine telephone circuits. All the conductors are stranded; the telephone conductors consist of copper wires, 1·45 mm. in diameter, and of two copper strips of 2·70 mm. by 0·35 mm.; the telegraph conductors are formed of three wires, each 0·9 mm. in diameter. In order to raise the self-induction of the telephone conductors, they are wound with iron wire, 0·2 mm. in diameter, on the Krarup system. The insulation is by paper, and together with this paper the core, inside the inner lead shell, has a diameter of 23·5 mm., or nearly 1 in. There is an outer lead shell, and between the two shells there are two layers of steel wires, 1·65 mm. in diameter, helically wound in opposite directions to give the cable strength. Outside the second lead tubing and the layers of jute and compound is the steel armour of interlocked S wires, of galvanised steel, 5 mm. in diameter, which bring the full diameter of the cable up to 52 mm., or a little over 2 in. The interlocked steel wires are an old speciality of the Felten and Guilleaume Carlswerk, A.G., of Köln-Mülheim, which made the whole cable. The cable weighs 11 tons per kilometre, or about 18 tons per mile, and was made very strong because it rests in the sea partly at a depth of 120 m. Before being laid the cable was tested in the works in lengths of 800 m. and of 11 km., and further in the three sections ready for shipping, having lengths of 21 km., 77 km. and 77 km.; the tests, finally of the whole cable, more than satisfied the specified conditions. The laying had to be in sections because the steamer Rudolf Hansen, which the Telegraph Department had chartered for the work, was merely a cargo boat of insufficient capacity, which had to be fitted up as an emergency cable ship. The two main cable sections extend from the shore end at Leba to the cable buoy anchored in the Baltic half-way over East Prussia, and from the buoy over Tenkitten; the splice was made on board. The laying did not give rise to any incidents. The special apparatus required for joining the cable to the aerial lines and to intensify the signals (by relays of the valve type) were supplied by the firm of Siemens and Halske, of the Wernerwerk. Excellent communication was carried on between Berlin and Königsberg in August the day after splicing the cable sections; but the land connections were not then ready for the public telegraph and telephone service.

Brick Prices.

The Government Committee appointed to ascertain whether the present high prices of bricks are in any way attributable to trusts and combines have reported in the negative. The trade is, they find, one subject to wide alternations of bad and good times, but in general before the war the trade was on the average far from being a profitable one. In 1900 and 1914, bricks were being sold at almost any price in order to get them out of the way, and during the war the trade suffered severely, and a great many firms were forced to close down. At the Armistice the output was one-fifth the normal pre-war output, and those firms that had been compelled to close down were faced with heavy expenses in attempting to restart owing to the dilapidation of buildings and plant. Government control was instituted in August, 1917, and prices fixed on the basis of costings by the Government accountants. The control was removed early in 1919. The following table shows how the price of bricks has altered since pre-war days:—

Locality.	Average Pre-War Selling Price.	Average Investigated Cost during Control (1918).	Average Controlled Price February 1919.	The Average Present Contract Price to the Government (June, 1920) at Works.
	per 1,000 bricks s. d.	per 1,000 bricks s. d.	per 1,000 bricks s. d.	per 1,000 bricks s. d.
Kent & Essex stocks	35 0	—	48 6 (Graded)	1st stocks .. 85 6 2nd stocks .. 80 6 Single roughs 59 6 3rd stocks .. 50 0
Fletton ..	27 6	27 8½	39 5	51 0
Manchester..	26 0	39 5	52 11	83 0
West of England	29 0	58 2	65 11	82 6

These prices are subject to further advances dependent upon increases in fuel, labour, &c. The principal costs in the trade are labour and fuel, and it may be noted that most of the cost of the fuel is also a labour cost. The report states that in 1914 the wages paid to an average labourer engaged in this industry varied from 4d. to 6½d. per hour, representing a weekly wage of 18s. 8d. to 30s. for 56 hours week. Since that period increases have been made from time to time until in June, 1920, the labourer was in receipt of a total advance of 43s. over and above his pre-war rate of wages. Taking the wages of the average labourer as 24s. per week before the war, he is now receiving a weekly wage of 67s., which represents an increase of approximately 180 per cent. When these various awards were made piece-workers, youths, women and boys were advanced proportionately, and no reduction in wages was made when the weekly hours of work were reduced from 56 to 48. The extent to which fuel regulates the price of bricks is dependent on locality and on the process of manufacture, so that it is impossible to state with any degree of accuracy any fixed figures showing the relation of fuel to the total cost. In the manufacture and burning of the common building brick the committee found that the quantity used varied from 4 cwts. to 11 cwts. per thousand, according to the clay and the amount of burning required. In the Fletton area the amount required is as low as 4 cwts. to 5 cwts., but in the other districts the average is 11 cwts. The increases in the prices of coal per ton in the principal districts have been as follows:—

	1914.	June, 1920.
London	15s.	50s.
Peterborough ...	5s. to 8s.	30s.
Manchester ...	8s. 6d.	37s.
West of England...	14s. 9d.	44s. 8d.
Scotland	8s.	30s. to 37s. 6d.

Taking the average of these five districts, the increase is approximately 270 per cent. In the case of stock bricks, where ashes are taken down to the yards from London and mixed with the clay, considerably less coal is required for burning purposes, and therefore coal does not form such an important factor in the price of this class of brick. The witnesses examined were unanimously agreed that the coal that is being supplied at the present day is of greatly inferior quality to that used before the war, with the result that its calorific value has depreciated, and about 25 per cent. more is required for purposes of burning and power production.

Advertising Exhibition.—An International Advertising Exhibition is to be opened at the White City, in November next, and the profits made are to go to charities connected with the advertising business. Full particulars can be obtained from the central offices of the exhibition, 167, Strand, London, W.C.2.

The Marine Oil Engine.—The Institute of Marine Engineers has decided to arrange for a series of lectures on the internal-combustion engine. Full details of the course have not yet been fixed, but a draft prospectus has been drawn up and will be discussed at a conference to be held in the Society's Lecture Room, on Wednesday, October 20, at 4 p.m.

THE LATE SIR JOHN McLAREN.

A notable figure in Leeds engineering circles has passed in the death on Tuesday last of Sir John McLaren, K.B.E. Sir John had been ill for several weeks when death occurred at his residence, Highfield House, Headingley, Leeds.

Born in April, 1850, at Hylton Castle, Sunderland, John McLaren was educated privately, passing the Durham University middle class examination in 1865. In 1866 he was apprenticed to Messrs. Black, Hawthorn and Co. of Gateshead and passed through their various shops and drawing office in the five years he was with them. During that time he passed the South Kensington Examinations with honours and for two years was a teacher of the South Kensington evening classes. In 1871 he had the sole management of the Ravensthorpe Engineering Company, of Mirfield, Yorks, and was engaged in designing and constructing colliery plant, steam ploughing machinery and steam engines, including steam sewage pumping plant.

In 1876, in conjunction with his brother Henry, he started the well-known firm of Messrs. J. and H. McLaren, Midland Engine Works, Leeds, with which he was connected, of course, at the time of his death. The firm soon began to secure important contracts, having in comparatively early days supplied pumping plant to the Mexican Drainage Works, and ploughing and clearing plant for the now well-known irrigation project at Mildura in Australia. The firm also specialised in steam electric-lighting engines.

When the war came Mr. McLaren was made Chairman of the Board of Management of the National Factories for Munitions, in Leeds, and his energy and powers of organisation were of immense service in this direction, a fact which has since been officially recognised by conferring on him the honour of K.B.E., in 1919. The Leeds shell factory, it may be remarked, was the first national factory of its kind in the country. Sir John was a member of the Central Committee of the Employers Federation, was president in 1918 of the Leeds Chamber of Commerce and for many years represented Leeds on the executive of the Association of British Chambers of Commerce. He served on the Royal Commissions for the International Exhibitions at Brussels, Turin and Rome.

Sir John joined the Institution of Civil Engineers in 1876 as an Associate Member, being transferred to the class of Member in 1892. In 1890, he read a paper before that Institution on "Steam on Common Roads," which on account of its date naturally dealt mainly with traction engines, &c. He was elected a Member of the Institution of Mechanical Engineers in 1903. He was an active member of the Agricultural Engineers Association, and was a well-known figure at many of the agricultural shows of the country. At the annual meeting last December of the Royal Agricultural Society he stated that he had attended that Society's show on no less than 51 occasions. As is well known, the firm of Messrs. McLaren specialise in ploughing machinery, one of the latest of their productions being illustrated and described on pp. 506 and 507 of our present issue. Sir John was a prominent member of Leeds Congregationalist circles; in politics he never sought any prominence. He was much liked by his fellow workers for his cheery disposition, which fact often undoubtedly contributed to his successful management.

THE LATE MR. GEORGE TANGYE.

Mr. George Tangye, the last survivor of the four brothers who founded the famous Birmingham firm, died on the 7th inst. at his residence, Heathfield Hall, Handsworth. He was in his eighty-fifth year, having been born at Broad Lane, Illogan, near Redruth, Cornwall, on October 1st, 1835, his father being a small farmer and shopkeeper. He received his early education at the parish school, and later at the Friends' School, Sidcup. His brother Richard having obtained a situation as clerk at the engineering works of Mr. Thomas Worsdell, Birmingham, in 1852, was followed there next year by the subject of our memoir, who was also engaged as a clerk. The other brothers obtained situations with the same firm as mechanics. Later the four started in business for themselves, hiring a workshop in Mount street for 4s. a week.

Their great chance came when Mr. Brunel adopted the hydraulic jack (invented by James Tangye in 1856) for overcoming the difficulties met with in launching the Great Eastern, which, with the aid of these new implements, took the water in 1858. The brothers next took up the manufacture and development of the Weston differential pulley block. In this work Mr. George Tangye is stated to have played a leading part. As a result of the great success and popularity of these blocks and the hydraulic jack the firm was enabled to move into larger premises in 1859, and in 1862 the manufacture of steam engines on a standardised interchangeable system was commenced. The business rapidly improved and the Cornwall works were in consequence erected near Boulton and Watt's old foundry in Soho. After the retirement of Joseph and James Tangye the business was carried on by the two younger brothers, but was converted into a limited liability company in 1881, under the style of Tangyes, Limited. In the subsequent development of the firm Mr. George Tangye played a prominent part, and was so successful that repeated additions had to be made to the works. In

The Late Mr. George Tangye.

1906, when Sir Richard Tangye died, Mr. George Tangye became chairman of the company. His benefactions to the city of Birmingham were numerous, and included important donations to the art gallery and to the municipal school of art. Another gift to the city was the fine collection of Boulton and Watt relics, which had been acquired by Mr. George Tangye and treasured by him for years.* This collection includes nearly 18,000 drawings. His home, Heathfield House, had previously been occupied by James Watt, and the latter's workshop was religiously maintained as a memorial to the father of steam engineering.

The Barrow and District Association of Engineers.—The programme for the ensuing session of the above society comprises a number of interesting papers. The opening meeting of the session was held on Friday last, when Mr. G. A. Bassett, R.C.N.C., M.I.N.A., read a paper on "Engineering in War and Peace." Other papers on the programme are as follows: November 12, 1920, "Care and Maintenance of Machinery Afloat," Eng.-Com. A. E. Lester, R.N., D.S.O.; December 10, 1920, "The Problem of the Gas Turbine," C. E. Beardmore, Esq.; January 14, 1921, "Mercantile Marine Oil Engines," A. H. Newlands, Esq.; February 11, 1921, "Modern Methods of Lubrication of High speed Bearings," G. W. Johnson, Esq.; March 11, 1921, "Electric Furnaces," T. Sedgwick, Esq. In addition, five lectures for apprentices have been arranged. These will deal with the following subjects:—"The Art of Moulding," J. Parker, Esq.; "Electrical Measurements and Electrical Measuring Instruments," H. G. Leivesley, Esq.; "Manufacture of Jigs and Gauges," J. Milner, Esq.; "Mechanical and Optical Measuring Appliances," J. W. Osborne, Esq.; "Sea Experience with Marine Oil Engines," H. Atkinson, Esq.

The University of Birmingham.—A meeting in furtherance of the raising of 500,000*l.* for the extension and improvement of Birmingham University was held at Birmingham on Friday last, under the presidency of the Chancellor, Lord Robert Cecil, M.P. Amongst those present was the Chancellor of the Exchequer, who pointed out that before the war the House of Commons voted something less than half a million in support of the universities and university colleges of the Kingdom. At present double this amount is voted, and next year he hoped to raise the sum to 1,500,000*l.*, in addition to certain special grants in aid of professional pensions. He emphasized the importance of avoiding State direction of universities, which should be free centres of thought. Lord Robert Cecil, in his speech, observed that in pre-war times we had in the United Kingdom only 5,000 full-time students in technology, whilst Germany had 17,000 and America 34,000. It may be observed, however, that these figures afford no indication whatever as to the quality of the output which in this country was fully equal to the best elsewhere. At the conclusion of the meeting, Alderman Clayton announced that conditional promises had already been received for two-fifths of the total aimed at.

* See Engineering, vol. cviii, page 637.

THE LATE MR. HENRY STEEL.

A large circle of engineers will regret to hear of the sudden death, at a comparatively early age, of Mr. Henry Steel, chairman of the United Steel Companies. Mr. Steel was only 58 and had scarcely known a day's illness in his life. He seemed to be in his usual good health last week, having come up to London on business, and a good deal of surprise was occasioned by the discovery on Thursday, the 7th inst., that Mr. Steel had died during the previous night.

Mr. Steel was the son of Mr. Henry Steel, of Tapton Court. He was educated in Brussels and at London University, after which he went into the Ickles works of Messrs. Steel, Peach and Tozer. Subsequently he was given a seat on the board. In 1915 he succeeded his father as chairman of that company, and commenced the negotiations which resulted in the present amalgamation.

The first firm to join with Messrs. Steel, Peach and Tozer in the amalgamation was that of Messrs. Samuel Fox and Co., Stocksbridge. Subsequent arrangements, concluded in 1918, resulted in a combination which included the Frodingham and Workington Iron and Steel Companies, the Rother Vale Collieries, Limited, and the Appleby Iron Company. Still more recently the Scunthorpe Iron Company, and the Dinnington Iron and Coal Company, came into the concern; while Messrs. Daniel Doncaster and Sons, Limited, the Martino Steel and Metal Company, have also entered the combination, which also has a large interest in Messrs. Thomas Smith and Co. The combine has capital of over 9,000,000*l.*, and it was Mr. H. Steel's ambition to make it self-contained from beginning to end.

In addition to the affairs of this large amalgamation, Mr. Steel held responsible offices in connection with several other important companies, so that he led an extremely busy life. He was reputed to be a very hard worker, full of energy. He was a good business man and an excellent manager, and his sudden death will entail a severe loss to the many organisations with which he has been prominently connected. He was made a member of the Iron and Steel Institute in 1886.

INDUSTRIAL NOTES.

In these "Notes" last week, on page 482, it was stated that "at Lincoln, Messrs. Ruston and Hornsby are suspending the remaining 400 of their employees till October 12." We regret having made this statement, as it is not correct. The majority of the departments of this company have work in hand to keep them in full employment for some months, but in one of them (the motor works), there is a slackness which has caused the suspension of about 400 workpeople until the date mentioned. The number of the firm's employees at Lincoln alone is over 5,000.

At a mass meeting of engineers employed on maintenance work in the Manchester area, held on the 10th inst., it was agreed to raise the ban on overtime which has existed since July 10 last, pending the settlement of the wages question.

The Federation of Engineering and Shipbuilding Trades is demanding an increase of 6*d.* per hour for time workers and an equivalent advance in piece work rates, and at the same time an advance of 3*d.* per hour is claimed for boys and apprentices. At a preliminary conference the depressed state of the industry was urged as a reason why such claims should not be pressed at present. The conference will be resumed on October 22. Similar claims for advances of wages are being made by the Amalgamated Society of Engineers.

It is interesting to note that the Glass-makers' Society is protesting against the provisions of the Young Persons Employment Bill which prohibits youths under 16 from working night shifts.

At the annual conference of the National Sailors' and Firemen's Union, which was held in London last week, it was proposed to increase by 30*s.* the present minimum of 4*l.* 7*s.* 6*d.* per week paid to sailors and firemen engaged in coastwise trade, with an addition of 5*l.* to the existing rates of 15*l.* to firemen and 14*l.* 10*s.* to sailors paid monthly. From the Scottish branches, recommendations were made to increase the wages of seamen and firemen to 6*l.* 10*s.* weekly and 20*l.* monthly. The claims of fishermen for increased pay were strongly pressed, and a further proposal urged the Executive Council to take immediate steps to secure improved remuneration for all ratings in the mercantile marine in view of the continued increase in the cost of living. The payment of seamen's wages, it was also claimed, should begin on the day when articles of agreement were signed, and not, as laid down

in the Merchant Shipping Act, from the day of joining a vessel; and "that wages should continue up to the time when the crew were discharged, and not when the vessel arrived at her berth." It was stated that the whole wages question would be brought before the National Maritime Board, in accordance with agreement, in a fortnight's time. The attention of the conference was drawn to a serious problem by a report from the Mersey district viewing with alarm "the continuous employment and importation of cheap Asiatic labour, while thousands of British seamen and firemen cannot secure employment," and urging the assistance of the Triple Alliance to remove the evil.

An important and characteristically courageous declaration was made at Llandudno last week by Mr. Lloyd George, to a deputation of ex-service men. He said that although there were a considerable number of ex-service men who could be employed in house building, there were trade union regulations which made it impossible at present for their services to be used. "That," continued the Premier, "ought not to be, and it is one of the things that I am going to apply myself to without delay. A Cabinet Committee has been sitting for some time investigating this question, and as soon as we get through our trouble with the miners—and I hope that will be soon—I shall certainly apply my mind to this matter with the view to seeing what can be done." It may be observed that ex-soldiers from Cromwell's Army had much to do with breaking up the iniquitous restrictions on labour and business imposed by the old Trade Guilds, and for the sake of the nation as a whole it may be hoped that history will repeat itself in this matter. At the same time, whilst insisting that ex-service men must be given the opportunity of qualifying for any calling they may desire to follow, the Government have offered exceedingly generous terms to all men employed on housing schemes. This offer provides for the payment of lost time up to half a week at the rate of 50 per cent. and for the payment of lost time over half a week at the rate of 75 per cent. Dissatisfaction with the scheme is due, however, not to the specific rates proposed, but to the accompanying provision that some measure of dilution must be accepted at the same time. This the men, with a regrettable absence of fairness and good feeling, are not prepared to accept. Labour representatives are fond of posing as idealists, but about 99 out of every 100 trade disputes are concerned solely with very materialistic questions, and when a claim for the improvement of the conditions of the "underdogs" is supported by the skilled trades, and a concession granted, this is almost immediately followed by another for higher pay on the part of the skilled men, so as to maintain their relative position unimpaired.

Negotiations between the employers and employees in the bleaching, dyeing and calico printing trades in Lancashire, Cheshire, Yorkshire and Derbyshire, on a wages demand, broke down at Manchester on Monday. The workers affected number 80,000. The present agreement expires on October 21, and there is a possibility of a complete cessation of work.

The result of the miners' ballot is unfortunate, but it is not yet possible to predict the future course of the controversy. The original strike was called in support of a demand for subsidising the home consumer at the expense of the export trade, plus an addition of 2*s.* per shift to the miner's pay. The first item in this programme has been abandoned, but the men show great reluctance to the establishment of any connection between pay and productivity. On the other hand, in certain mining areas there seems to be a disposition to accept the Government's alternative proposal for submitting the wages question to an impartial tribunal. Neither side at present appears to accept the statistics of the other.

For many decades America was notorious for "cornering operations," which in spite of their disastrous effects on the well-being of the community, met for long with little reprobation; the successful operator being in fact not uncommonly an object of admiration. During the past few years, however, a very marked change has been evident in the views of the press and the business community in the United States, and amongst the middle classes at any rate this unfair exploitation of the public needs is no longer considered compatible with good citizenship. In this regard American opinion and British are now in accord. Another class has, however, recently discovered that "cornering" the public may, temporarily at least, be remunerative, and there is great danger that "labour corners" may be as great a detriment to the public weal in the future as wheat corners and the like have been in the past. In one respect, the new type of corner is worse than the old, since, owing to the relative simplicity of most of the work to be done, such corners can hardly be successful unless supported by intimidation. Ultimately, no doubt, the "non-social" and fundamentally tyrannical character of such conduct will be realised by this new class of operator, as it has been by its predecessors in this baneful field.

In the 18 trades for which figures are regularly published, the average weekly earnings of the employees in the representative establishments during the week ending August 28 were 52*s.* 6*d.* as compared with 52*s.* 10*d.* a month earlier, 33*s.* 8*d.* just before the armistice, and 18*s.* 2*d.* in June, 1914. The percentage increases, respectively, being since the armistice, 56 per cent., and since June, 1914, 188 per cent. These averages relate to trades employing a very high proportion of young women and girls. The decline of 4*d.* per week is the first decline recorded since 1915. The wage changes reported in August, 1920, affected 1,102,000 persons, who had increases aggregating 252,700*l.* per week. For the first eight months of 1920 the figures are: January to August, 1920: Number of workpeople affected, 7,089,000; amount of net increase per week, 3,579,000. These figures exclude any wage changes affecting Government employees, domestic servants, agricultural labourers, shop assistants and clerks. Making some allowance for loss of time during holidays the increases this year are equivalent to an annual total increased wage bill of about 180,000,000*l.* If we had statistics for all wage earners, the total would probably exceed 280,000,000*l.* Out of the 128 different cases of increases of wages affecting 1,102,000 persons during July, in only 11 cases involving 9,000 workpeople were the changes preceded by disputes causing stoppage of work.

The Bill to amend the Merchant Shipping Acts of 1894–1920, introduced by Mr. J. Sexton, includes a proposal that "Except in case of grave emergency, no seaman or apprentice on a British ship is to be employed more than 8 hours a day or more than 48 hours per week." Obviously the promoter has entirely failed to realise the fundamental difference between work afloat and work ashore. The worker ashore has a spell of relaxation every week, whilst the seaman has instead a long spell at home and a long spell at sea. Moreover, at sea 7 days' work a week is essential, and in favourable weather the job is usually of a light character, so that 12 hours "on deck" is not in any way comparable with 12 hours' work in a factory, since during most of his spell on deck a seaman is merely standing by in case he is required; nor has he to spend time or money in travelling to and fro between his sleeping place and his job. Where the work is continuous, as it is for firemen, the 8-hour day is already in vogue. If the Bill passed it would necessitate an increase of 6*l.* 14*s.* in the first-class fare to New York, and of from 2*l.* 10*s.* to 7*l.* 14*s.* in the steerage fares. Some ships in the home trade, moreover, spend 85 per cent. of their time in port. In France, where seamen's time is already regulated by law, the difficulty is overcome by a system of substituted leave. By this the seaman gets so many days' leave at the end of the voyage for the number of hours he has worked "overtime" beyond the 56 hours' week whilst at sea.

In one of the Ingoldsby Legends the remark occurs that the devil is at all times more easy to raise than to lay, and much sympathy is due to those labour leaders who are risking their popularity by drawing attention to certain "evidential facts" relative to the present condition of industry. Though they have been to blame in the past for standing by, whilst unintelligent orators declared that to increase output was merely to benefit the capitalist, this reluctance to criticise a nominal friend or supporter, no matter how absurd his remarks, is unfortunately only too commonplace. The late Sir E. J. Reed, for example, once observed that he had never intended to be bound by speeches made by some of his supporters even in his presence, and he had raised no protest at the meeting. No doubt the hypothesis that productivity benefits only the capitalist was never subscribed to by the thinking men amongst the labour leaders, but few, like Mr. J. H. Thomas, have yet had the courage to speak frankly in this matter. At a meeting in London last Saturday he denounced "the fallacy of doing as little as possible with the idea that you are giving employment to someone else." His observations on the triple alliance at the same meeting will find perhaps less general acceptance. He claimed that it was "not a brutal power ready and anxious to strangle the community." So far as the rank and file are concerned, and many of the leaders, this statement is probably correct. The sight of means to do ill deeds is, however, notoriously often the occasion of such deeds being done, and the concentration of so much power into the hands of men irresponsible to the nation at large is undoubtedly a danger to the community. On the other hand Mr. Thomas's appeal to employers to give labour a fair deal will, we hope, meet with immediate response. No doubt there may be differences of opinion as to what is "fair" in particular cases, but the obviously unfair can at least be avoided, and of this there have been far too frequent instances in the past.

The truth of the old fable of the contest between the sun and the wind and the traveller's cloak is exemplified by the condition of the iron and steel trades, where for years past it has been the practice to avoid disputes, in part by basing wage rates on selling prices, and in part by timely negotiation, in which conciliation is the object rather than victory for one side or the other. Such methods, it is true, do not afford much scope to ambitious young men, as it is much easier to be eloquent on grievances, real or imaginary, or on the supposed iniquity of social inequalities, than it is to study out fair adjustments of prices when new methods or processes are introduced. This latter plan has, however, given peace and prosperity to the steel workers, with, of course, the exception of the aforesaid ambitious young men, and the steel workers have secured without a fight at least as high wage increases as other more militant trades. This preference for the square deal, as opposed to a fight, has in short been highly profitable to the men, since the general advance in wages has been 200 per cent. to 230 per cent. above the pre-war level.

Electric Railways in Japan.—The Department for Overseas Trade reports that a Bill is to be introduced into the Japanese Diet with the object of organising a semi-official electric power company, with a capital of 100 million yen. The company will supply current for working trains on the suburban railways.

The Whitworth Scholarships.—The four Whitworth Scholarships have this year been all taken by students from H.M. Dockyards. The list is headed by Mr. A. Beale, who has received his theoretical training at the Portsmouth Municipal College; the second and third places are occupied by other students from the same college, whilst the fourth was educated at the Sheerness Technical Institute. Of the 12 exhibitions only five hail from other places than the dockyards, and of these four were trained at the Sunderland Technical College. The full number of exhibitions could not be awarded owing to the low standard attained. This, no doubt, is an aftermath of the war, as the technical training of many young engineers suffered seriously from the exigencies of the time. Two of the successful candidates for exhibitions had the age limit extended on account of their war services.

The Manchester Association of Engineers.—The opening meeting of the new session of the Manchester Association of Engineers was held on Saturday last, when the new president, Mr. H. Pilling, M.B.E., M.I.Mech.E., delivered his inaugural address. In this he suggested that the association should pay greater consideration to the needs of rising young men, and instanced the fact that the Manchester Branch of the Institution of Electrical Engineers had nearly 200 student members, who were encouraged to contribute papers, many of which had proved to be of surprising merit. He warmly reprobated the not infrequent practice by which, if a young man showed capacity and will to learn, his chiefs watched him zealously and carefully kept him steadily to his individual job, so as to restrict his opportunities for acquiring valuable knowledge.

Scholarships for Apprentices.—At a meeting held last week, the Glasgow University Court approved of the regulations proposed for scholarships which are to be given to apprentices employed in the Tyne and Wear works of Messrs. Swan, Hunter and Wigham Richardson, Limited, Wallsend, and by Messrs. Barclay, Curle and Co., Limited, Glasgow. The scheme provides for one scholarship each in naval architecture and in marine engineering at Glasgow University for apprentices employed by Messrs. Barclay, Curle and Co., and similar scholarships at the Armstrong College, Newcastle, for apprentices employed by Messrs. Swan, Hunter and Wigham Richardson. The object of the companies is to encourage self-improvement and the pursuit of scientific studies among their apprentices, so as to help the most deserving to obtain a University degree in naval architecture or marine engineering, and in general to raise the standard of knowledge in shipbuilding and marine engineering. The scholarships, which will be tenable for three years, will be awarded as the result of competitive examination, the firms paying all fees, granting 25*l.* per year towards the cost of necessary technical books, instruments, &c., and making also a subsistence allowance of 2*l.* per week during the continuance of each University term. Sixty per cent. of the total marks obtainable in the competition will be allocated to the technical examination, and the remaining 40 per cent. will relate to "general conduct, character, workmanship, and timekeeping during the period that has been spent in the works." The time occupied in the University course will count in full as part of the scholar's apprenticeship. The first examination will be held in the forthcoming winter session. The candidates must be British subjects not over 18 years of age, and must have been in the employment of the firm for at least one year preceding the examination.

7½-TON SIX-WHEEL COMMERCIAL VEHICLE.

CONSTRUCTED BY MESSRS. G. SCAMMELL AND NEPHEW, LIMITED, ENGINEERS, LONDON.

Fig. 1.

In view of rising wages and other costs any transport device which promises to cut down charges is of very considerable interest. One obvious way of reducing costs of road transport is to increase the weight of load which can be handled by one vehicle and one road crew, and the interesting six-wheel lorry which has been brought out by Messrs. G. Scammell and Nephew, Limited, of Spitalfields, London, E. 1, would appear to fulfil this condition admirably. A general view of the vehicle is given in Fig. 1, above. As will be seen, it consists of a four-wheel chassis carrying the engine, and arranged to draw a two-wheel body which pivots on a turntable at the rear of the chassis. The weight of the complete vehicle is 4½ tons and it can carry a weight of 7½ tons without exceeding an axle load of 6 tons, which is the limit allowable for a vehicle travelling at 12 miles an hour. The vehicle is able, in addition, to draw a 6-ton trailer, so that a total useful load of 13½ tons can be dealt with. For many intermittent services a load of this order is not necessary, and frequently cannot be obtained, but for much of the haulage now done by motor vehicles this very considerable increase in capacity is of the first importance, and the machine is likely to prove of great value. This lorry is not, of course, the first six-wheeler which has been produced, but it contains many points of novelty and interest which add to its usefulness and efficiency.

The details of construction of the chassis and the general form of the transmission will be followed from Figs. 2 and 3, opposite. The chassis frame is a pressing, and the engine and gear-box are carried on a sub-frame and have three-point suspension. The engine is of the four-cylinder type and develops 47 brake horse-power at 1,000 r.p.m. We will refer to its details later. It drives through a Ferodo-lined cone clutch with an aluminium male member. Between the clutch and gear-box there are two star-type universal joints. The gear-box is a one-piece aluminium casting, and the gear wheels are of 100-ton tensile steel. They are mounted on splined shafts and there are no bolts, keys or other loose pieces in the gear-box. The gate of the striking gear is mounted on the gear-box and not connected to the frame. The box gives three speeds forward and one reverse. Behind the gear-box there is a cardan shaft foot-brake with the fulcrum bracket mounted on a cross-member, so that no braking strain is thrown on the transmission. The drive is on to a jackshaft through bevel-reduction gear, all differential gear being mounted in the jackshaft casing. There is a compound universal star-wheel, completely enclosed and running in grease, between the jackshaft and the gear-box.

The final drive is by chains from the jackshaft to the driving wheels of the chassis. This driving axle and its suspension form one of the most interesting features of the vehicle. The arrangement is such that none of the weight of the body comes on the frame or springs of the chassis. The axle is tubular, 4 in. in diameter, and is made of 60-ton steel. The radius rod attachment and the brake fulcrum are combined in single steel castings. The wheels are of cast steel and the sprockets are bolted on the spokes. The chassis is carried on light flat underhung springs, 2½ in. wide, while the load is carried by heavier top springs which also pull the body through the medium of the turntable. This arrangement results in the chassis or motor unit bearing no weight of the body load on its axle and springing independently. The turntable is built up of six pressings, 4 in. by 2 in. by ¼ in., with their gussets interlaced so that no distortion can take place. The centre of the turntable is a spigot which pulls the body and allows it to swing laterally. The body frame is 14 ft. long, and at the front end is of an arch form so that it lies over the frame of the chassis and is capable of independent vertical movement. To secure the body frame on the turntable a shoe locked by a spring trigger movement on the outside of the frame is provided. By withdrawing the spring trigger the body is easily attached or detached.

The braking arrangements are of much interest. As before mentioned there is a hand-operated cardan shaft brake. In addition there are expanding brakes on the driving wheels with Ferodo-lined shoes, and with hand adjustment and automatic release. The brake drums are 11 in. in diameter, with 5-in. faces. There are also brakes on the rear wheels, i.e., the wheels carrying the body frame. The drums are 16 in. in diameter, with 2-in. faces. These brakes can be operated no matter what the angular position of the body may be in reference to the chassis. The brakes are controlled by a hand lever which is connected to a bell-crank lever situated below the centre of the turntable. The movement of this lever lifts a steel pin which slides up and down inside the spigot, and the top end of the pin engages with a second bell-crank which is carried on the body frame and connects up with the two rear wheel brakes. The carrier wheels are of cast steel, and the axle is 3 in. diameter, of tubular section. Before dealing with the engine we may mention that the front chassis wheels are also of cast steel, that the front axle is of H-section, and that the steering gear is of the Ackerman type.

The engine is illustrated in Figs. 4 and 5, on page 520. The four cylinders are each 5 in. diameter by 5½ in. stroke. They are cast in pairs. The valves, as will be seen are in the head, and the combustion chambers are machined all over the engines in many respects following aero-engine practice; and great attention has been paid to following a stream-line form in the ports. The valves are of tungsten steel and are interchangeable. The joints between the cylinders and heads are made with two copper rings, ¼ in. wide, and the bolts are disposed so as to ensure equal pressure all over the joint. Both cylinders and head are jacketted, but no water passes between them except by an outside transfer port. The arrangement of the valve operating gear is quite clearly shown in Figs. 4 and 5. The tappet rods are tubular and are adjustable from the top of the cylinder head. The rockers are carried on tubes which act as oil reservoirs and are filled from outside. The valve gear is totally enclosed and works in an oil mist. The camshaft is a one-piece forging and runs in die-cast bearings.

The crankshaft is a drop forging, and runs in three bearings, and the connecting rods are of H-section with hollow gudgeon pins, 1¼ in. diameter. The pistons are of cast iron, with internal webbing to assist heat dissipation. Lubrication is from a submerged pump, bolted to the bottom of the crank-case. An oil relief valve is incorporated in the pump casing. There are no external lubricating pipes. The pump delivers, at 10 lb. pressure, direct to the hollow crankshaft. The camshaft is lubricated by splash. The valve gear is lubricated from the hollow tappet shaft already referred to and by oil mist rising from the crank-case. Cooling is by water pump having a 5-in. shrouded impeller. No bearings are in contact with the water. The radiator is of the built-up type, with top and bottom tanks and four rows of tubes. It is mounted on rubber washers on the front cross-member of the frame, and frame distortion does not affect it. The engine is fitted with a Zenith carburettor, and the inlet pipes to the engine are of copper to avoid internal roughness and give a clear flow. The uptake is jacketted with hot water taken from the top of the engine. A Watford magneto is fitted and a 22 in. diameter aluminium cooling fan driven by a Whittle belt. An example of this interesting vehicle, together with special trailers, will be on view at the Commercial Motor Exhibition which opens at Olympia to-day.

Queensland Iron and Steel Works.—At present there are two big iron and steel works in the Commonwealth, and an important addition to the engineering resources of the Commonwealth will be made when the Queensland Government establishes its large works at Bowen, in the vicinity of which ample supplies of coking coal are available. The capacity of the first plant will be large, as may be judged from the following essential appliances included in the installation: One blast-furnace plant, to produce 350 tons of pig-iron per day, with hot stoves and complete blast-furnace equipment; also slag cement plant attached. One battery of by-produce coke ovens to supply coke, both for the blast furnace and also for sale purposes. Four open-hearth steel furnaces, each of 60 tons capacity, and a hot metal mixer of 500 tons capacity, both fitted with the most modern equipment.

"D.B.S." Handbooks.—Messrs. David Brown and Sons (Hudd.), Limited, Lockwood, Huddersfield, have recently sent us a series of their handbooks which are of a very interesting character. Four of these handbooks relate to the firm's worm-wheel generator, worm miller, worm grinder, and hob sharpener and worm gear tester. The pagination is consecutive through the series, each section, separately bound, being of about 24 pages. Each section is arranged on the same plan, in which a description of the machine is given first, followed by distinctive features and working instructions. The books are well illustrated, and an ingenious system of references enables the reader to pick out the points in the illustrations very quickly. In the text a system of numbers is used in connection with references to particular parts. Thus in the text the words, for example, appear: "The collet-chuck spindle 61/36," the interpretation of the symbol being the part figured 61 on the illustration on page 36. The reader is always directed to the illustration showing the part referred to most clearly. The parts are figured in a regular order across or up and down the page, and the figures are bold and placed in regular lines away from the blocks, with indicator arrows to the part they refer to. Additional pamphlets describe the firm's new spur-gear generator and double-helical gear generator, the method of treatment being similar. These machines we described on page 364 *ante*. The pamphlets give a good deal more information in them than the demands on our space then permitted us to do.

7½-TON SIX-WHEEL COMMERCIAL VEHICLE.

CONSTRUCTED BY MESSRS. G. SCAMMELL AND NEPHEW, LIMITED, ENGINEERS, LONDON.

(*For Description, see opposite Page.*)

Fig. 2.

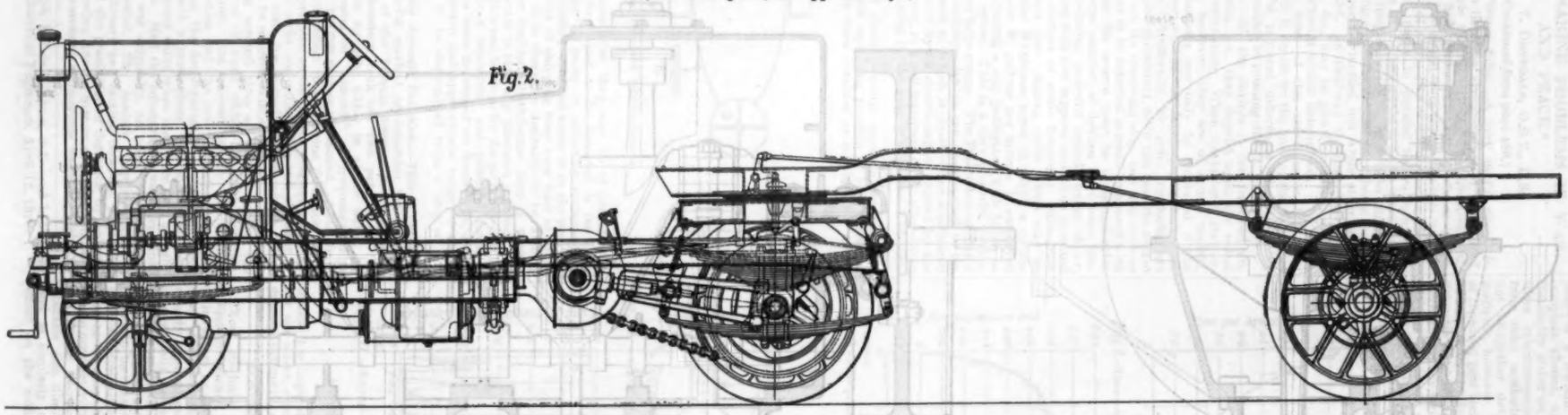
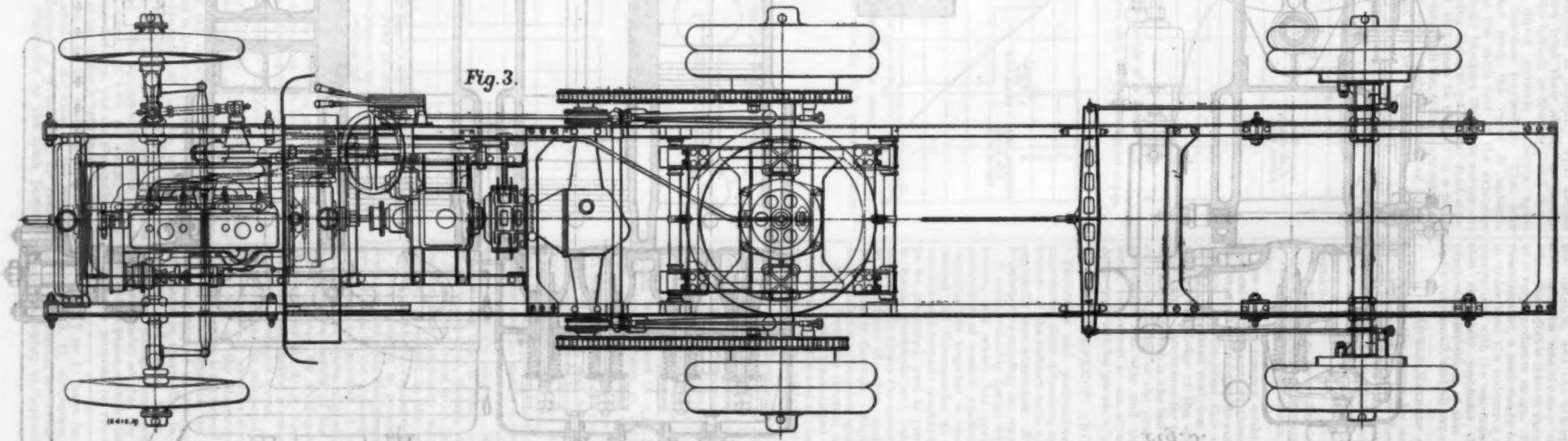


Fig. 3.



THE COLOURING OF GLASS BY RADIUM EMANATION.—Why glasses and also silica exposed to the radiations of radium become coloured in the course of time, is not really understood, though the problem has been independently investigated by several workers. A paper on the subject published by S. C. Lind in the *Journal of Physical Chemistry*, of June last, is a critical survey of the observations made rather than an attempt to explain the phenomena. Glass, and also fused silica, are mostly coloured violet or bluish. Some glass takes a brown tint; this holds particularly for lead glasses and also for hard glasses of the Jena and pyrex types; the brown colour develops more slowly than the violet. The initial shade always persists. But Meyer and Przibram, who communicated a report on the subject to the Vienna Academy in 1912, also observed that some glasses turn violet in some parts and brown in others; bottles containing solutions of radium salts became violet above the water line, but brown below it, and the difference was also observed in bottles containing dry salts; Lind never observed this. The colour disappears on heating the glass, the violet only when the glass begins to soften (about 500 deg. C.), the brown at lower temperatures (of 200 deg. about). Exposure to sunlight will destroy the colouring in the course of months. Meyer and Przibram also noticed that brown glass, heated gently, turned violet; when this colour was destroyed by more intense heating, the glass became violet on re-exposure to radiations. Here, then, a change of colour was actually noticed, and Lind confirms this observation. Glass freshly radiated upon becomes thermo-luminescent by gentle heating to about 100 deg. C. In glass which has not been exposed to radiations for a year or more, the heating must be carried to 200 deg. and more to produce luminescence. Mechanical disintegration of silica vessels containing radium salts was noticed by Rutherford; Lind never observed this in glass bottles, but he had not used silica containers. Newberry and Lupton (Manchester) have recently ascribed the colouring to the dissociation of certain traces of impurities, the colour depending upon the size of the particles and the distance to which the disturbance (by the radiations) of the molecular structure had separated the particles. That would imply that pure substances should not show the phenomenon; but Goldstein coloured crystals of pure potassium chloride deep violet by kathode rays, and such chlorides are assumed to be partly reduced to metal and subchloride by the radiations.

ENGINE FOR 7½-TON SIX-WHEEL COMMERCIAL VEHICLE.

CONSTRUCTED BY MESSRS. G. SCAMMELL AND NEPHEW, LIMITED, ENGINEERS, LONDON.

(*For Description, see Page* 518.)

Fig. 4.

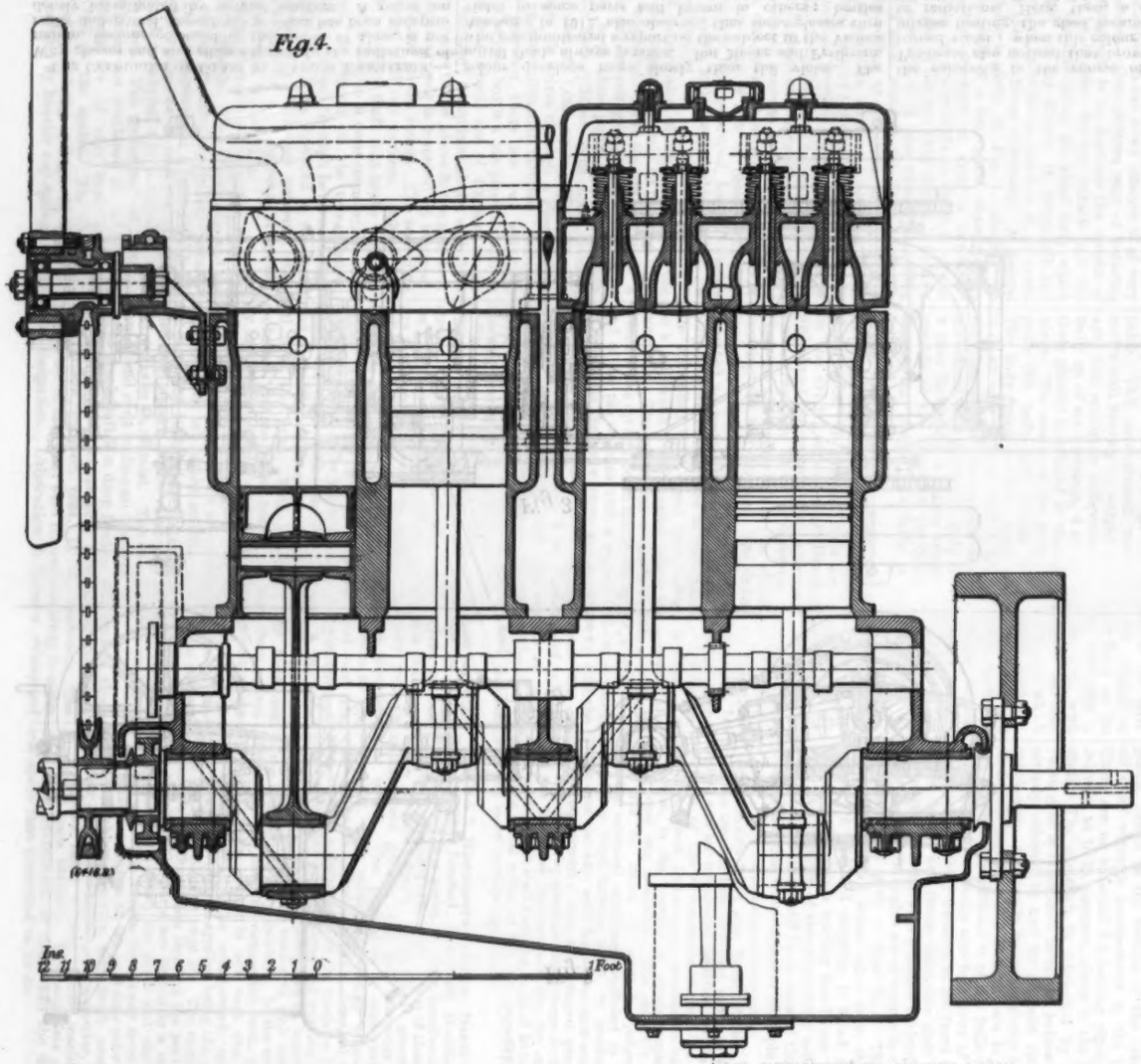
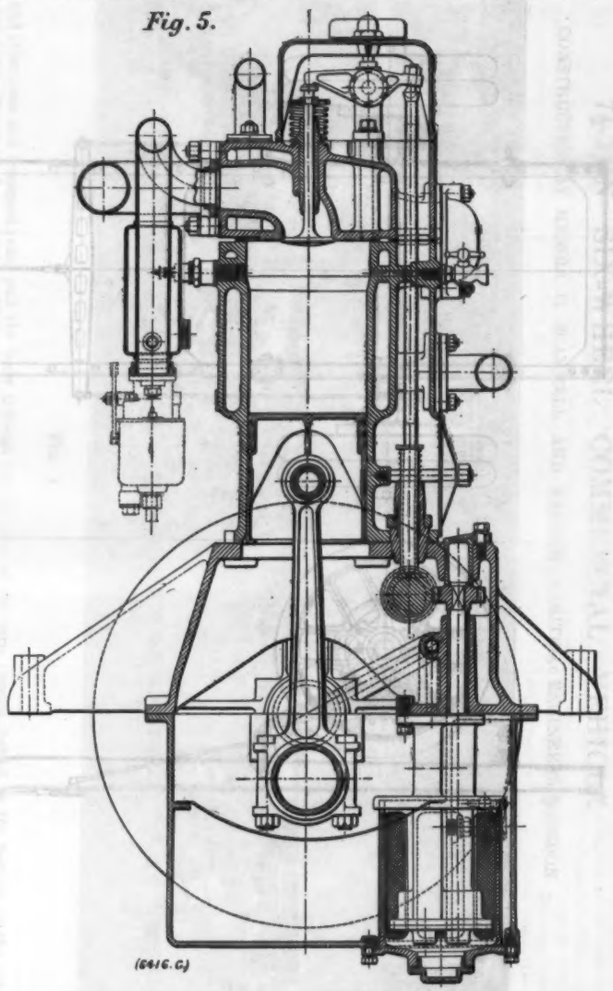


Fig. 5.



Machinery for the Preparation of Fibre.—Our Legation at Havana reports that an inquiry has been received from an applicant in Havana for the names of United Kingdom manufacturers of machinery for the preparation of a kind of fibre, known as "Paxte" by the natives of Central America, and referred to in Spanish-speaking countries as "Estropajo." The fibre in question, it appears, is used in the manufacture of articles such as sponges (loofah), bathroom slippers, hats and light mattresses for tropical countries, &c. The machinery required would be: (1) For removing the green outer covering, slitting up the pod and removing the seeds; (2) for utilising the fibre for the manufacture of the various articles commonly made from it, as mentioned above. The applicant further stated that a company with a capital of 130,000 dols., of which he was the manager, had been formed in Havana for the exploiting of this fibre, that they had secured land near Havana for plantations in which to grow the plant from which the fibre is obtained, and that they would possibly be prepared to begin operations next summer. Further particulars can be obtained on application to the Department of Overseas Trade, 35, Old Queen-street, London, S.W. 1.

MODERN MARINE PROBLEMS IN WAR AND PEACE.*

By C. V. DRYSDALE, O.B.E., D.Sc.

(*Continued from page* 486.)

Burgess interference tubes.—A very useful device in connection with listening arrangements of every kind and which assists the reduction of disturbances with non-integrating hydrophones, is that introduced by Mr. J. A. Burgess. The sound from the receivers is led into an arrangement of tubes like a trombone so that it divides into two paths in parallel before re-uniting. If the difference of the two paths is half a wave-length for a particular frequency, that sound will be eliminated and by employing a number of pairs of tubes a number of frequencies can be blotted out while other sounds can still be heard. In this way the disturbances due to water noises, &c., may be greatly reduced, and the frequencies of different sounds determined.

An improved form of this arrangement has been devised by Mr. B. S. Smith on the lines of the American compensator, the required differences of path being obtained by a number of rotating discs.

Echo methods.—All the devices so far described are for direct listening, i.e., they depend upon the sound emitted by the submarine. When the latter is stationary or drifting, however, they are of course useless, and acoustic methods can only be employed if the submarine either reflects or intercepts sound from another source. Reflection or echo methods are naturally the more convenient, as in this case the source of sound can be on the observing ship, and it is obvious that as the object to be detected is small compared with any useful range the source must be of considerable intensity. A large number of devices have been constructed for producing powerful sounds under water, such as submarine bells and tappers, oscillators operated by alternating current of sonic frequency, submarine syrens and steam jets. Among those which may be mentioned are the Wrightson syren in which a stream of water of about 30 gallons per minute is employed with a motor rotating a cup perforated with holes, as in the ordinary syren. This is a very powerful device, but needs a rather large pump. The Fessenden oscillator consists of a diaphragm which can be attached to the side of a ship and to which is fixed either a soft-iron armature attracted by an electromagnet excited by the alternating current, or a coil traversed by an alternating current and moving in the gap of a powerful electromagnet.

By means of these powerful acoustic transmitters, not only is sound signalling possible at long distances but echoes have been obtained at considerable range.

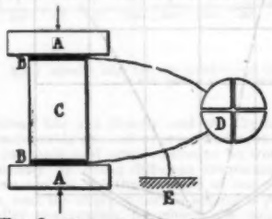


Fig. 9.—Piezo-electric phenomenon.

For open deep-sea work they may be of considerable value, where the object to be detected is far away from other ships or rocks or reflecting surfaces, but for working in shallow confined areas or in the presence of a large amount of shipping they may lead to great confusion, and it is therefore desirable to be able to concentrate the emitted disturbance into a narrow beam and to rotate it into any direction required. As has been seen, this can be done by the principle of integration, and most interesting and powerful methods of location have been developed on these lines, which enable the direction and approximate range of a submerged object to be determined from a ship at full speed.

High-Frequency Acoustic Detection.—This is probably the most powerful method of detection yet devised, and arose out of the Titanic disaster in 1912, when Mr. Lewis Richardson took out two patents for detecting obstacles by echo either in air or water, by employing a beam of "sound" of frequency from 5,000 periods to 100,000 periods per second. Apart from their special application to submarine detection, these echo methods promise to be of the greatest value for the detection of rocks and other ships and probably of icebergs, and also for sounding operations. Their application will be referred to later.

The foregoing account gives an outline only of the immense amount of work which has been done on acoustic detection. On account of the sensitiveness of acoustic devices and the low absorption of sound waves in the sea, the development of acoustic methods must always hold a great place, and they most certainly were of great value when they were first brought to service state. Had the submarine always remained as noisy as it was originally, no other devices would have been needed. The modern improvements in submarine machinery and tactics, however, have very greatly reduced the possibility of detection by acoustic means. By running slow on motors or by drifting with the tides and currents, submarines have been able to preserve a certain amount of mobility with almost complete silence, apart from their ability to remain stationary either on the bottom or floating; and under these circumstances direct acoustic detection apart from echo methods becomes impossible. This does not altogether detract from the value of acoustic methods, however, as the mere fact of the existence of listening gear seriously hampers the rapid movement of submarines by forcing them to go almost dead slow. Acoustic gear may in this sense be likened to a police force which may seriously limit the activities of criminals without convicting or even detecting them, and in this respect its value must always be recognised. Nevertheless it is imperative to have other methods of detecting the silent submarine, but this is a matter of the greatest difficulty, as indicated at the outset.

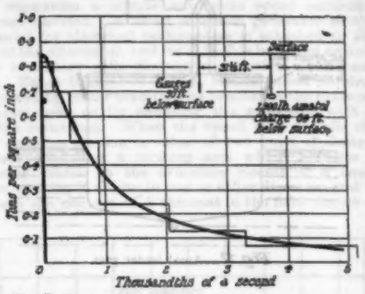

Tons per square inch
Surface
50 ft.
Gauges 50 ft. below surface
1 cwt. amatol charge 50 ft. below surface
Thousandths of a second

Fig. 7.—Time-pressure curve for 1,000 lb. amatol charge.

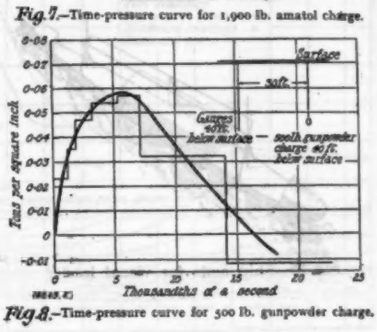

Tons per square inch
Surface
50 ft.
Gauges 50 ft. below surface
500 lb. gunpowder charge 50 ft. below surface
Thousandths of a second

Fig. 8.—Time-pressure curve for 500 lb. gunpowder charge.

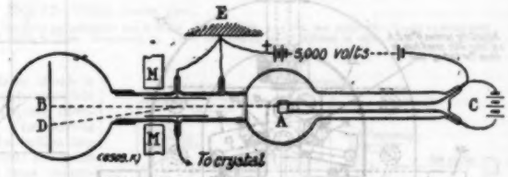


Fig. 10.—Cathode-ray oscillograph.

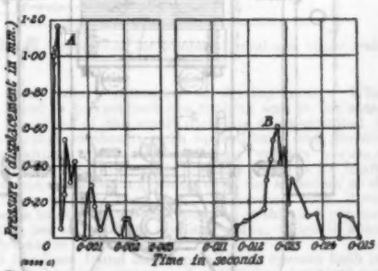


Fig. 11.—Explosion-pressure record from cathode-ray oscillograph.

A Original shock. B Reflected impulse.

ELECTROMAGNETIC METHODS.

These methods are usually based on the Hughes induction balance, which was seized on by a number of inventors as the most attractive principle for detection. Unfortunately this impression is illusory, as has already been indicated in the introduction. The method is essentially heterodynamic, so that we have to deal with the attenuation of the magnetic field from the coils and again with that of the induced field from the object to be detected. The magnetic field from a coil of small dimensions compared with the range, diminishes as the cube of the distance, and the absorption due to the conductivity of the water is very large at all but the lowest frequencies. As the reaction due to the obstacle also diminishes as the cube of the distance and is similarly affected by absorption, its reactive effect on the coils diminishes as the sixth power of the distance, and the absorption is squared, so that although the sensitiveness may be remarkably great when the object is close to the coils, it practically vanishes at a very moderate range. From the point of view of measurement, a moderately high frequency is desirable, in order that the inductive effects should be large in comparison with the resistance of the coils; but absorption absolutely precludes this. In consequence the practical possibilities of this method seem theoretically to be very small, and all experience has confirmed this.

OTHER METHODS OF DETECTION.

Although the above by no means exhausts the list of methods which have been experimented with or employed, it covers the bulk of useful and promising devices. Certain optical methods have been employed with some success, but do not warrant description. Thermal devices as above mentioned do not seem promising.

In addition to detection devices much valuable work has been done as regards secret signalling which may be a valuable aid to detection, but this cannot be gone into.

For obvious reasons nothing can be said about the tactical employment of these devices, which, however, has engaged a considerable amount of attention.

Since the Armistice this detectional work has gone on with unabated zeal, but it has been realised that a greater knowledge of the scientific principles involved is of prime importance for future development, and this will be dealt with in the last section. In view, however, of the difficulty of the problem, the small amount of knowledge available and the exigencies of war-time work, the record is one of which our country and our Allies may well be proud.

II.—DEFENCE AND DESTRUCTION.

Defensive and destructive methods are of no less importance than detection, and form a most fascinating branch of the subject with which the lecturer has more especially been concerned. The bulk of the applications to submarine mining, &c., must, however, be kept secret.

A most valuable device which has become fairly well known and which has probably done more for the protection of vessels against mines than all other inventions put together is the paravane, which was invented by Commander C. D. Burney, R.N. This consists of a torpedo-shaped body towed from the vessel to be protected, and is provided with vanes so that it keeps outwards and below the ship. When the towing cable meets the mooring rope of a mine it forces it away from the ship, and the rope slips into jaws which cut it through. Explosive paravanes have also been made for protection against submarines.

Apart from the internal mechanism of mines, there are the problems associated with laying them in water of different depths and of their motion in tides and currents, as well as with their destructive effect. These problems are of the most intricate character and have engaged a very large amount of attention. One matter which may be referred to here is the determination of the pressures developed in the water by explosive charges of different magnitudes. This has been investigated by two independent methods.

In the first of these, which has been most ably employed by Mr. H. W. Hilliar, the pressure is measured by the compression of small copper gauges similar to those used in ordnance trials. A number of these gauges is enclosed in cylindrical holes in steel blocks, with steel plungers of different lengths. When the explosion wave reaches the block, the steel plungers are driven in and compress the gauges, but the time for the plunger to reach the block depends on its mass and length of travel and hence the variation of pressure with time can be determined. Fig. 7* shows one of these time-pressure curves taken at a distance from a 1,900 lb. amatol charge at a distance of 92½ ft. and at a depth of 64 ft., the gauges being 50 ft. below the surface. The pressure rises to nearly a ton per square inch in about 10,000th of a second and falls to about a tenth of this value in 0·004 second. With a gunpowder charge (Fig. 8) the rise of pressure is much slower and it is longer maintained, though of much smaller intensity.

It has been found from these experiments that these high-pressure explosion waves travel with the same velocity as sound in the water (about 4,900 ft. per second), that the explosive charge required to produce a given pressure is proportional to the cube of the distance, and that the pressure is sustained for a time proportional to the distance.

The second method of making such investigations is of a most interesting scientific character, and gives a continuous record of the variation of pressure. It was suggested by Professor Sir J. J. Thomson and developed by Mr. D. A. Keys at Shandon, and depends on the piezo-electric phenomenon so fully studied by the late Professor Curie. If a crystal such as quartz or tourmaline is subjected to pressure along its optic axis (Fig. 9) it becomes electrically charged on its surfaces, and as the elasticity of such crystals is very high this charge is developed practically instantaneously, and is proportional to the total force on the crystal independently of its dimensions. By mounting plates of quartz or tourmaline in contact with a rigid metal backing and facing them with an insulated tinfoil sheet, the charge developed can be communicated to an electrometer so that the arrangement makes a very convenient pressure indicator.

For the purpose of recording very rapidly-varying

* The eleventh Kelvin Lecture, delivered before the Institution of Electrical Engineers, April 15, 1920.

* Figs. 7 to 11 have been taken from a paper by Professor J. C. McLennan, F.R.S., entitled "Science in its Application to Marine Problems," read before the Northern Society of Shipbuilders.

pressures a cathode-ray oscillograph is used. The form hitherto employed was lent by the Cavendish Laboratory and is shown in Fig. 10. A stream of electrons is emitted by an 8 volt tungsten filament in a bulb, and passes through a pinhole aperture in a copper anode, between which and the filament a constant potential difference of about 4,000 volts is maintained by a high-voltage generator. The fine cathode-ray pencil thus produced passes first between the poles of a laminated electro-magnet, and then between two long brass plates which are respectively connected to the tinfoil coating of the crystal receiver and to earth. After passing these plates the cathode-ray pencil passes into a camera in which a fluorescent screen is fixed. The whole apparatus is exhausted to an X-ray vacuum by means of Gaede and auxiliary pumps. When the filament is glowing and the high potential difference is applied, a bright spot is seen on the fluorescent screen. On exciting the electro-magnet this spot moves transversely across the screen in a direction perpendicular to the magnetic field, and on applying a small potential difference between the two brass plates, it moves in a direction at right angles to this. For the purpose of obtaining the records the electromagnet is excited by an alternating current of about 80 ~ per second, causing the spot to move over the screen in a simple harmonic manner, each traverse taking 1/160th second. The crystal receiver is suspended in the water with its face turned towards the explosive charge, and is connected through a highly insulated low-capacity cable to the brass electrode plate of the oscillograph. When the explosion occurs the beam is deviated laterally by an amount proportional to the pressure at each instant and a time-pressure curve is traced out on the screen. This can be recorded by lowering a photographic plate in front of the screen, by means of a cord and pulley turned through an air-tight gland.

Fig. 11 is a record obtained by this device after reducing the time intervals to a uniform scale. It shows considerable irregularities, possibly due to reverberations in the water and to non-simultaneous firing of different portions of the charge, but its general form corresponds fairly well to the curves obtained by Mr. Hilliar. Absolute pressures were not obtained, but arrangements have been made for calibrating the device by applying known pressures.

An interesting point shown in curve B is that the reflection of the pressure wave by the bottom of the sea produces a second impulse of magnitude comparable with the direct impulse. It has also been found both from Mr. Hilliar's and from Mr. Keys's experiments that surface reflections produce tension waves of magnitudes sometimes exceeding the static pressure, indicating that the water may actually sustain a considerable tension for short intervals.

The practical importance of these experiments is very great, as it enables the destructive radius of various mines to be determined and the designs of mines and mine-fields to be conducted on a scientific basis. On this account, and for many other investigations, a new form of cathode-ray oscillograph has been designed at Shandon which is portable and self contained, and in which a roll-film camera is employed, actuated from outside by electromagnetic mechanism. Arrangements have also been made for attaining a uniform time scale so that the record needs no after-treatment.

A number of special instruments have also been devised for studying and recording the motions of mines in tideways, &c.

III. NAVIGATIONAL APPLICATIONS.

One of the most fortunate circumstances resulting from the large amount of research undertaken for war purposes is that the majority of the information and devices so evolved have the most important application to peace-time navigation.

Although ships and ordinary methods of navigation had already been developed before the war to the extent of rendering maritime transit remarkably safe and almost independent of storms, fog has always been a serious and dangerous obstacle, causing great delay, apart from accidents, while the dangers of icebergs, derelicts and uncharted rocks need no insisting on. The Titanic disaster in 1912 brought these dangers vividly before the public, and several suggestions were made soon after for guarding against them, some of which as mentioned above have been of value in the anti-submarine campaign.

The question of safe and rapid navigation in foggy weather is a matter of great imperial importance, as the Canadian service is often seriously delayed by fog off the Banks and at Halifax and the St. Lawrence River, so that passengers and goods often travel by the American routes for greater certainty.

The three chief desiderata for the safety and regularity of navigation appear to be as follows, in the order of their importance:—

(1) Ability to find and enter a harbour in foggy weather.
(2) Location of position in sea during fogs.
(3) Detection and location of ships and obstacles in darkness and fog.

These three requirements can now respectively be met to a considerable extent by the following devices:—

(a) Leader gear.
(b) Sound ranging and directional wireless.
(c) Echo detection.

Fortunately it is possible to deal with these matters in greater detail.

Leader Gear.

This device which promises soon to come into considerable practical use, consists of laying down a cable on the bottom along the track which it is desired to follow, and supplying it with alternating current of either sonic or infra-sonic frequency. By the use of suitable coils or electrodes attached to the ship the electro-magnetic induction or the return currents in the water can be made to give signals in telephones or other devices by which the course of the cable may be followed.

Attempts were first made in this direction in the St. Lawrence River by Professor R. S. Owen as early as 1903, but were only partially successful, chiefly because amplifiers were not then available. During the war the idea was revived by Captain Manson, employing search coils and amplifiers, and successful

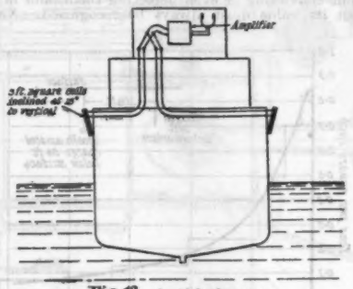


Fig. 12.—Aural leader gear.

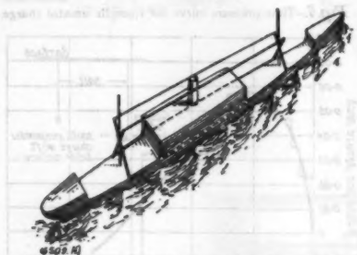


Fig. 13.—Ship coils for visual leader

results were immediately obtained. Two coils of about 4 ft. square are fixed on the sides of the ship a short distance away from the ironwork, and are connected to a change-over switch and three-valve amplifier and telephones. The cable is supplied with alternating current of a frequency of about 500 ~ per second and this current is cut up into signals by an automatic interrupter. Steering is effected by listening on the two coils alternately, the signals being stronger on the side of the ship nearer to the cable. The difference in intensity is apparently due to the screening action of the iron hull, and varies with the size of the ship, but it is usually possible to find positions of the coils which give good indications. Fig. 12 is a diagram of the arrangements.

In order to avoid the necessity for listening to telephones, the author has attempted the somewhat bold step of employing tuned alternating relays to operate lamps on the navigating bridge of the ship, and thus to give continuous visual indications. For this purpose two inclined coils of a few turns are fixed in the rigging as shown in Fig. 13. If the lines of magnetic force are in circles round the cable as generally supposed (Fig. 14), the electromotive forces induced in the two coils should be equal when the ship is vertically over the cable, but when it is on one or other side the E.M.F. in the coil pointing more nearly towards the cable will be the higher. At a certain lateral distance from the cable the plane of one of the coils will be tangential to the lines of force, and will consequently have no E.M.F. induced in it.

Fig. 15 shows the construction of the alternating-

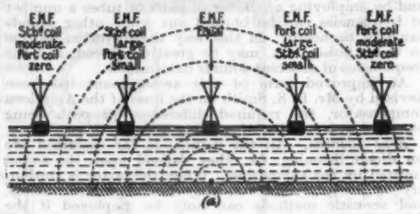

E.M.F. Starb'd coil moderate. Port coil zero.
E.M.F. Starb'd coil large. Port coil small.
E.M.F. Equal
E.M.F. Port coil large. Starb'd coil small.
E.M.F. Port coil moderate. Starb'd coil zero.
(a)

Fig. 14 (a).—Ordinary circular field distribution showing E.M.F.'s in sloping visual leader-gear coils.

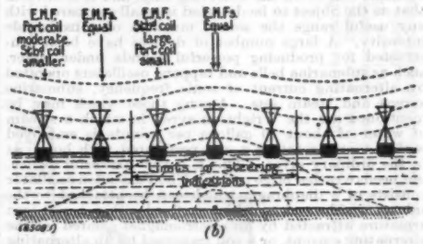


Fig. 14 (b).—Field distribution distorted by sea water, showing E.M.F.'s in visual leader-gear coils.

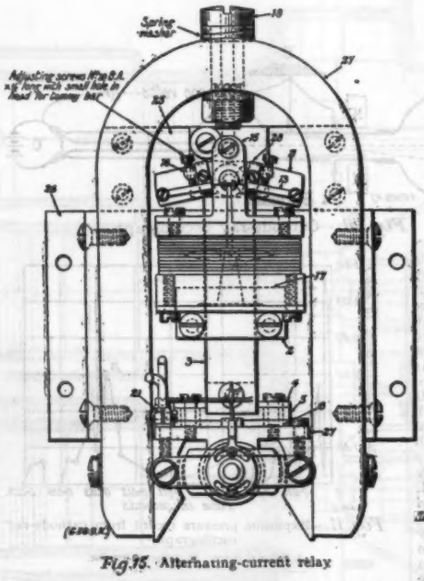


Fig. 15.—Alternating-current relay

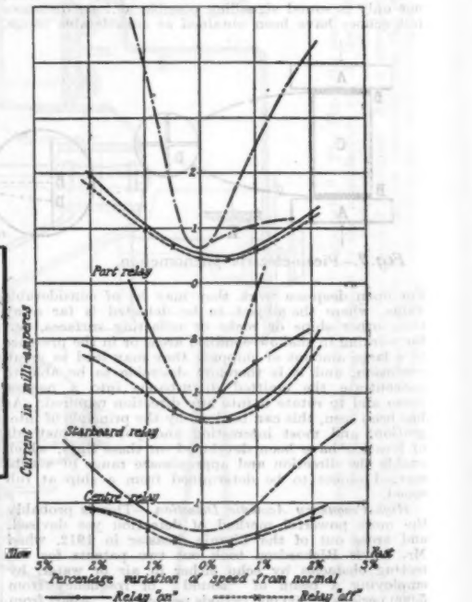


Fig. 16.—Resonance curves for alternating-current relays: variation of sensitiveness with frequency. Triple set in iron box with large tremblers.

current relays employed in conjunction with this device. It is on the same principle as the author's vibration galvanometer, in which a pivoted or suspended iron needle vibrates in the field of a horseshoe magnet and can be tuned by varying the intensity of the magnetic field. This needle is enclosed in a simple coil carrying the alternating current, and is provided with an arm carrying a rounded platinum end which makes contact with two fine tangential platinum wires when it vibrates. As the contact is intermittent, it is found desirable to convert it into a continuous contact by the simple device of passing the local current from the vibrating contacts through the coil of an ordinary heavily-damped moving-coil relay, the contact arm of which slides between two sets of parallel platinum-wire brushes so that when the coil is deflected, and oscillates owing to the intermittency of the current, it maintains a

continuous rubbing contact against the brushes. The two relays are combined in a single magnet as shown, and the tuning is very simply effected by traversing the whole of the alternating-current system along the axis of the magnet by means of a screw, so as to be in a stronger or weaker magnetic field.

It is fairly easy to set the contacts of this relay to work with a power consumption of 0·01 microwatt or less, which is amply sufficient to enable it to switch on a glow lamp at ½ mile from a cable carrying only 5 amperes of alternating current in a depth of water of 20 fathoms.

A relay on a similar principle was devised by Mr. Sidney Evershed as far back as 1896, but was unfortunately unknown to the lecturer at the time. Mr. Evershed went much further and designed a vibrating wire relay which operated with only 0·0001 microwatt, but it is desirable to have a fairly robust instrument for use on shipboard and it is necessary that the relay should be fairly definitely metrical in its operation for the present purpose.

The tuning of this relay is fairly sharp, as is shown by the curves in Fig. 16, and this requires the frequency of the current supplied to the cable to be maintained constant within about ½ per cent. of its nominal frequency, but this has the attendant advantage that different cables can be used with different frequencies without mutual interference. For example, in wide estuaries like the Mersey and the Clyde where there is a considerable amount of cross traffic, it is easily possible for the main and cross routes to be worked quite independently by using different frequencies. The curves shown are for the three relays of one of the indicating sets, and the sharper curves are for a previous set with smaller movement, in which the tuning was inconveniently sharp.

In order to keep absorption and distortion of the electromagnetic field as small as possible, low frequencies of between 10 ~ and 20 ~ per second are used with this device, and this makes the presence of the cable almost undetectable unless the frequency is known.

Unfortunately, however, when this device was first experimented with it was found practically impossible to get definite port and starboard indications for steering purposes, and it was therefore found necessary to investigate the distribution of the magnetic field by observing the E.M.F.'s induced in the two inclined leader gear coils, with the result that it was found that even at these low frequencies it was greatly distorted. Fig. 17 shows the distribution determined in the case of a cable in about 100 ft. depth of water with a frequency of 13 ~ per second. It will be seen that at the points marked A and B where the lines of force should be nearly vertical according to the ordinary theory, they are actually horizontal, so that instead of one relay being out of operation both are equally affected, and there can be no port or starboard indication. At greater distances from the cable the magnetic field actually bends upwards again, so that the indications are reversed. In order to avoid ambiguity, therefore, it is necessary to limit the sensitiveness of the relays so that they can only operate with an E.M.F. above its value at the points of inflection, and the steering indications must be limited to a range of 60 yards to 70 yards on either side of the cable as shown in the lower part of Fig. 14, which is ample, however, for navigating a narrow channel. In order to give even sharper indication of the position of the cable, a pointer indicator on the ohmmeter principle may be used, which is actuated by the contacts of the alternating-current relays. When the two relays are vibrating equally, the average value of the intermittent current from the contacts of each is the same, and the needle points directly down to the cable, but if the ship is on one side and the electromotive forces in the coil are therefore unequal, the average duration of contact in one relay is greater than in the other and the pointer goes over to the side on which the cable lies.

A triple alternating-current relay set is used, two of the relays actuating the port and starboard red and green lamps, while the centre relay is set to maximum sensitiveness and switches on a white "approach" lamp, indicating the first approach to the cable at a distance of ½ mile to ¼ mile. After this lamp lights, the ship keeps on the same course until the red and green lights glow and then steers along the cable by the latter.

In the early experiments with this device the frequency was hand-regulated by means of a simple stroboscopic device, in which a Neon tube illuminated from the contact of a standard tuning-fork was used in connection with a geometrical disc on the rotary-converter shaft. In order to avoid the necessity for hand regulation a simple automatic speed controller has been devised. A small magneto generator of the type used for electrical tachometers is attached to the shaft of the alternator, and its E.M.F. is balanced against a few secondary cells through a sensitive moving-coil relay. Exact balance of E.M.F. for the speed required is obtained by either rotating the brushes of the magneto by screw gear or by shunting the generator with a variable resistance. When the speed rises or falls the relay switches on one or other of two pairs of electromagnets actuating a rocking arm which actuates a reversing switch in the armature circuit of a small motor, causing it to run in one or other direction and to traverse the contact of a rheostat in the field circuit of the main rotary converter or driving motor. When the speed is correct and the rocking arm is horizontal the armature of the small motor is short-circuited by two springs so that it pulls up suddenly and prevents overrunning, while if the supply voltage varies so greatly as to traverse the contact near to its limits, an electric bell is rung which calls the attention of the engineer to the need for adjustment. This device appears to control the frequency to within 0·1 per cent. or 0·2 per cent. of its nominal value, which is amply sufficient for the leader gear.

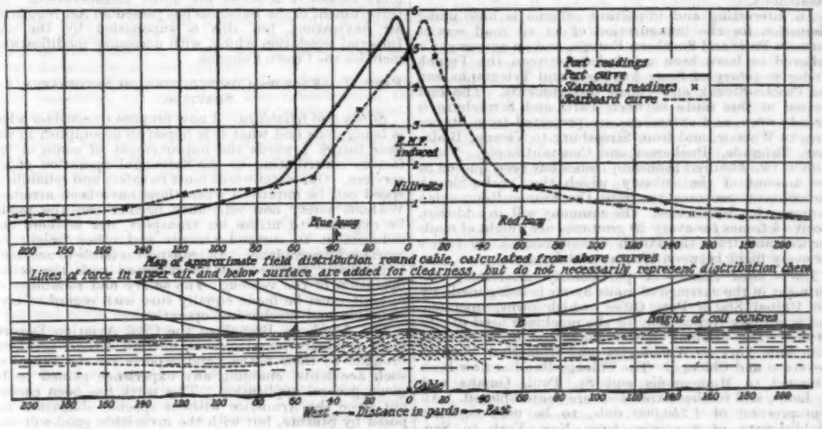

Port readings
Port curve
Starboard readings
Starboard curve
E.M.F. induced
Millivolts
Blue buoy
Red buoy
Map of approximate field distribution round cable, calculated from above curves
Lines of force in upper air and below surface are added for clearness, but do not necessarily represent distribution there
Height of coil centres
A
B
Cable
West ← Distance in yards → East

Fig. 17.—Visual leader gear.

E.M.F. induced in ships' coils with spreaders 20 ft. long. Vibration galvanometer 300 in series. Sensitiveness, 3·43 cm. per millivolt. Vessel crossing west to east, heading south. Current in cable 6 amps. Frequency, 13 ~ per sec. Depth, 16–17 fathoms at cable.

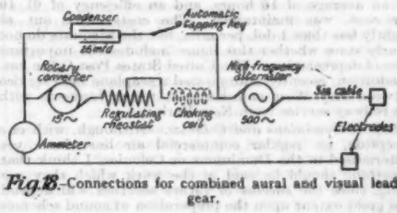


Fig. 18.—Connections for combined aural and visual leader gear.

It has been found easily possible to operate both the aural and visual systems of indication simultaneously on the same ship and with the same cable. For this purpose the cable is supplied from a high-frequency and a low-frequency alternator in series shown in Fig. 18. The inductance of the low-frequency machine is sufficient to choke down the high-frequency current almost completely, but by connecting a 20-mfd. condenser in series with the automatic signalling key across the armature of this low-frequency machine, the interrupted high-frequency supply can be maintained without affecting the low-frequency supply. It is therefore possible for ships to use either the aural or the visual indicating systems with the same cable, or to combine both indicating arrangements on the same ship without mutual interference.

Leader gear promises shortly to be adopted for practical navigation, as a cable about 18 miles long has been laid down at Portsmouth, and a notice appeared in the *Naval and Military Record* of March 10 last that this cable is available for use by vessels fitted with the necessary receiving apparatus.

Acoustic methods using submarine bells for guiding ships have been in use for a considerable time, and have been developed by the Submarine Signal Company in the United States. They may be employed with great utility in conjunction with leader gear by having a sounding device at the end of the leader cable, enabling the ship to steer towards the end of the cable from a distance of 10 miles or more.

(To be continued.)

BRITISH STANDARD ROLLED STEEL SECTIONS FOR STRUCTURAL PURPOSES.

A REVISED edition of the Lists of British Standard Rolled Steel Sections for Structural Purposes (Report No. 1, 1920) has now been published by the British Engineering Standards Association. It may be recalled that the original lists were issued in 1903 and comprised 166 sections. They were extensively adopted by users and steelmakers, and in 1913, the last normal year prior to the war, returns supplied to the association by the rolling mills showed that over 95 per cent. of the output of structural shapes in this country were rolled to the British standards. A revised edition was brought out in 1914, in which nine new sections were included, and one section which had fallen into disuse was omitted, making a net increase of eight sections, thus bringing the total number up to 174. The experience of the war having indicated that a fewer number of standard sections would probably meet the requirements of shipbuilders, structural engineers and others, particularly if some of the sections were redesigned, it was decided towards the end of 1917 to revise the British standard lists with this object in view. The three sectional committees dealing respectively with steel for (*a*) Ships, (*b*) Bridges and General Building Construction, and (*c*) Railway Rolling-Stock Underframes, upon each of which the steelmakers were officially represented, accordingly proceeded with the revision from the standpoint of their own requirements, and subsequently held joint meetings, when the present revised lists were unanimously agreed upon. The total number of standard sections now included is 113, a reduction of 53 upon that in the original lists. The beam sections have been re-designed to give a greater efficiency in comparison with weight and are divided into two lists, namely, (6—A) Girder Sections, and (6—B) Heavy Beams and Pillars. Bulb tees and zed bars are now eliminated from the standards. The form of the bulb in bulb angles and bulb plates has been considerably modified so as to give a more efficient section. The weights per foot and sectional areas of the standard sections are given in the present report, and it is understood that the other properties of the sections, such as the moments of inertia, will be issued in a later publication. Each series of shapes is numbered consecutively and independently as in the original list of British standard sections, and in order to prevent confusion with these the letter N is prefixed to the letters designating the form of section. For example, the new 8-in. by 4-in. beam is designated N.B.S.B. 7, whereas the original section was B.S.B. 13. For the same reason a new series of code words is provided for telegraphic purposes, a separate code word being given for each standard thickness where more than one for a given size of section is provided for in the lists, as in the case of the angles and tee bars, where two and sometimes three standard thicknesses are listed. It appears that these standard lists were adopted by the three sectional committees concerned in October, 1919, and would have been published before had not a desire been expressed in America, where the original British standards had been adopted for shipbuilding during the war, that agreement should be come to with regard to the new sections. Accordingly the publication was delayed in order that the American Engineering Standards Committee might have an opportunity of consulting the steel industry of the United States of America as to the applicability of the revised British standards to American practice. Considerable progress towards Anglo-American agreement has already been effected, and as British standards are revised periodically, it is hoped that when the present document again comes under consideration further conferences with the American Engineering Standards Committee may have proved fruitful and the results be incorporated in the next revision. The report may be obtained from the offices of the British Engineering Standards Association, 28, Victoria-street, S.W. 1, or from Messrs. Crosby, Lockwood and Son, 7, Stationers' Hall-court, E.C. 4, price 1*s.* 3*d.* post free.

ANNUAL REPORT OF THE UNITED STATES NATIONAL ADVISORY COMMITTEE FOR AERONAUTICS.—The fourth annual report on the work of this committee for the year 1918, has only recently been published by the United States Government Printing Office, Washington, D.C., U.S.A., the delay being mainly due to difficulties in connection with the printing. The committee includes standing committees and special sub-committees dealing with aircraft-design, navigation, power plants, standardisation and several other branches of aeronautics work, all of which are discussed in the report. From the conclusion of the latter it is evident that the committee believe that the United States is destined to take the leading place in both civil and military aviation, and they therefore recommend that the estimates submitted by the War, Navy and Post Office Departments be considered with a view to placing America in this position. The importance of continuing scientific research and experimental work in aeronautics is also emphasised. The main report occupies some 50 pages out of a total of 654 pages in the whole volume, the remainder being utilised for the reprinting of Technical Reports Nos. 24 to 50 inclusive. These Technical Reports contain much valuable matter in connection with aerodynamics, stability of aeroplanes, airscrews, aero-engine design fuels for aero engines, engine tests, airships, &c., but most of them have been issued previously and are obtainable on application to the National Advisory Committee for Aeronautics, Washington, D.C., U.S.A.

CIVIL AVIATION AND AIR SERVICES.*

By Major-General Sir F. H. Sykes, C.B.E., K.C.B., C.M.G., Controller-General of Civil Aviation.

Introduction.—Aviation is divided into two main branches, civil aviation, comprising the two industries—aircraft construction and civilian air transport—which together aim at the acceleration of intercommunication and the expansion of trade by means of air transport; and service aviation, the ultimate object of which is direct defence. The two branches are independent, yet closely allied; independent in that commercial and fighting types of machine and the problems presented in their development continually tend to diverge; closely allied, because in future the actual cadres which compose the country's service air forces in peace can only be augmented in war emergency by a reserve of men, who might easily be placed on a volunteer basis, by material and experience in construction and design afforded by commercial aviation. The duties of air forces, once war is joined, will consist—in addition to manœuvring to attack enemy air, land and sea forces and territory, and to defend home territory from the air—in enabling arterial air routes to continue in operation by protecting them from hostile air attack. It is evident, however, that commercial aviation cannot be fostered merely as a reserve for the country's air forces. Its test must be that of commercial success. Civil air transport is in much the same position to-day as military aviation was before the war. It is its many possibilities which give it such an unique interest. Not yet two years have elapsed since the armistice was signed and already numerous experiments are being conducted in the operation of air services in different parts of the world, and their initial results have been such that their number shows no sign of diminution.

Civil aircraft is of great use in the high-speed carriage of mails, small valuable goods, passengers and for sundry purposes, such as mapping and survey work, but mails—at all events for the time being—are the basis upon which commercial aviation, both from the constructional and transport sides, must develop. It is the purpose of this paper to illustrate the growth of, and work carried out by, air mail, passenger and goods services as they exist at present at home, in the Empire, and abroad; to investigate some of the factors contributing to their success; and to put forward some suggestions as to future development.

Part I. Growth and Present Position of Air Mail Passenger and Goods Services.

United Kingdom—Internal.—There are, as yet, no internal air services in the United Kingdom—a fact chiefly due to the comparatively short distances to be covered, the excellence of existing communications, and the uncertainty of meteorological conditions. I believe, however, that Messrs. Beardmore intend to start an experimental service between London and Glasgow in the near future, and I hope this venture will succeed and will be the precursor of further air lines in this country.

United Kingdom—Continent.—There are at present three direct routes from England to the Continent, i.e., from London to Paris (223 miles), Brussels (210 miles) and Amsterdam (258 miles). The first regular daily service to Paris was inaugurated by the Aircraft Transport and Travel Company on August 25, 1919. On May 1, 1920, a double service was started, machines leaving the State-owned aerodrome at Croydon morning and afternoon. The Instone Company and the Air Post of Banks have also established services between London and Paris. A fourth service is operated by Messrs. Handley Page from their private aerodrome at Cricklewood, where customs facilities are provided. The single fare for passengers by any of these lines, which covers 30 lb. of personal luggage, is 10 guineas, and the return fare 18 guineas; or 11d. and 10d. a mile respectively. Freight rates, quoted on a sliding scale, vary from 1*s.* 9*d.* to 2*s.* a lb. for 1 lb. to 10 lb., and from 1*s.* to 1*s.* 3*d.* for every pound above 100 lb. On the London–Paris route mails are carried by the Aircraft Transport and Travel Company. The original charge for letters was 2*s.* an ounce in addition to the ordinary postage fees, but this has now been reduced to 2*d.* an ounce, with an optional addition of 6*d.* for express delivery.

The London-Brussels mail service is operated by Messrs. Handley Page. Machines leave Cricklewood daily at 2.30 p.m., and arrive at Brussels at 5.30 p.m. All the charges are the same as those on the London–Paris route. This service affords an acceleration of at least 24 hours in the delivery of letters by ordinary mail to countries beyond. The Handley Page Company also holds the contract for the carriage of mails between London and Amsterdam, which is the junction for air lines to Germany and Scandinavia. Machines leave Cricklewood at 2.30 p.m., and reach Amsterdam at 5.30 p.m. The "air fee" is 3*d.* per ounce; the fare for passengers is 15 guineas, or 1*s.* 3½*d.* a mile. Freight charges are the same as above. The Aircraft Transport and Travel Company also conduct a service on this route. Arrangements have been made by the Postmaster-General with the French Post Office for letters to be forwarded by French air mail from Toulouse to Rabat on payment of a special air fee. Correspondence for Egypt, India and the East, if posted in time for air mail on Friday morning, will secure connection with ordinary mail despatched from London on the previous evening.

Foreign.

France.—French air transport companies, assisted by the Government subsidy scheme, which I shall deal with later, have established a number of services. There are four between Paris and London, two scheduled to run daily, the others spasmodic. A service runs from Paris to Brussels, a distance of 165 miles, the passenger's single fare being 250 francs. Postage fees for these services are 75 centimes for 20 grammes. The whole of the Bordeaux-Nice line is now believed to be in operation. During the first quarter of 1920, 62 flights, a total distance of 9,775 miles, were made between Bordeaux and Toulouse, and 20 passengers were carried; and it is probable that this number was considerably increased during the summer months.

The French air authorities have been swift to appreciate the advantages of, and to encourage, air communication between the mother country and her North African colonies, with the result that the Latecoere Company has for several months operated a tri-weekly service between Toulouse, Tangier and Rabat (recently extended to Casablanca), a distance of 983 miles. The charges on this route are moderate, the postage fee being 1·25 francs for 20 grammes and 1·58 francs a mile for passengers. By an arrangement with the Spanish postal authorities, the Latecoere Company is responsible for the carriage of mails between Alicante and Malaga. Forty-seven flights were made and 40 passengers, about 950 lb. of goods and 70 lb. of mails, were carried on this route during the first quarter of 1920. A subsidiary service is conducted five times a week between Malaga and Casablanca.

An interesting and important scheme is now under discussion for the inauguration of an air mail service between Paris and Southern Europe, and an agreement is believed to have been concluded between the French Under-Secretary of State for Posts and Telegraphs and the Czecho-Slovak and Polish Governments. The first section of this route between Paris and Strassburg is already open, and extensions are projected from Strassburg to Warsaw, and from Strassburg to Vienna, Budapest, Belgrade, Bucharest and Constantinople. Three million two hundred thousand francs has been quoted as the amount of the subsidy which the Czecho-Slovak Government proposes to grant the Franco-Roumanian Company for this service. The company will, in addition, receive 5 francs for every 20 grammes net weight of mails carried, and from the Polish Government 3,000 francs for every flight between Warsaw and Prague.

The United States.—A particularly interesting experiment in the carriage of mails by air is being made by the United States Post Office, which owns, operates, and is entirely responsible for the machines used in this service. The original lines inaugurated in 1918 were from New York to Washington and from New York to Cleveland and Chicago. The Chicago line has now been extended to Minneapolis and St. Paul, Omaha and St. Louis, and further extensions are contemplated. An appropriation of 1,250,000 dols. to be used for the establishment of a service from New York to San Francisco was passed by Congress this year. According to the Postmaster-General, between May 15, 1918, and January, 1920, these services operated over 473,210 miles, carried 22,254,400 letters. Delivery was advanced by an average of 16 hours, and an efficiency of 91·49 per cent. was maintained. The costs work out at slightly less than 1 dol. per mile, but the accounts do not clearly state whether this figure includes the important item of depreciation. The United States Post Office has, in addition, recently inaugurated a seaplane mail service between Key West and Havana, which connects with the railway service from New York.

British Dominions and Colonies.—Although, with one exception, no regular commercial air lines have yet materialised in the Dominions or Colonies, I think that something should be said of the work which they are doing, since the success of future services will depend to a great extent upon the preparation of sound schemes of ground organisation.

Canada, India and New Zealand have instituted Air Boards. The Canadian Board, whose functions are similar to those of the Air Council in Great Britain, acts in close co-operation with the Associate Air Research Committee and the Meteorological Department (which has undertaken to establish pilot balloons and observation stations for studying the upper atmosphere). All the Canadian Government air stations will be available for commercial traffic, and the Superintendent of Flying Operations, the member of the Board responsible for all civil aviation undertaken by the Government, has disposed of a number of hangars to municipalities to encourage and assist the establishment of public air ports. The Board is experimenting in photo-topographical surveying in the province of Quebec and in the Ottawa and Toronto districts, and the preliminary survey of a proposed air route between Winnipeg and Sudbury in Ontario has been carried out. A number of certificates and licences have been issued, and it is an important feature of the Canadian scheme that persons taking out civilian certificates at the same time agree to become members of the Canadian Air Militia and to attend an instruction course for at least one month in every two years. Attention is being paid to the production of new types of machines. Manufacturers will submit preliminary drawings, according to specification, to the Board, which, if it approves them, will place orders for trial machines.

The Indian Board, which is under the administration of the Department of Commerce and Industry, has decided upon the provision of aerodromes on the Calcutta–Bombay–Delhi–Karachi, Karachi–Bombay and Calcutta–Rangoon routes. The relatively equitable weather conditions of India, its size, and the volume of potential air traffic, should lead to the steady development of commercial air transport. There is no doubt that the progressive element of the commercial world in India recognises the advantages of, and would welcome, the establishment of air transport services on a commercial basis.

Both Canada and India have drawn up air regulations, and the New Zealand Aviation Act of 1919 empowers the Governor-General to make regulations by Order-in-Council for the issue of licences to flying schools and pilots, the registration of aircraft and prohibited areas. The New Zealand Board includes representatives of the Departments of Land and Survey, Public Works and Post Office, and its functions are to consider and advise on all questions connected with aviation; to maintain touch with the British Air Ministry; and to keep pace with modern developments throughout the world. By arrangement with the Department of Posts and Telegraphs, contracts were entered into by the Flying School at Auckland for the carriage of mails in the vicinity of that town, but the present shortage of petrol has interfered with the project.

Australia possesses an Air Service Committee; the South African Government is examining the whole question of aviation; and the interest of both Dominions has been stimulated by the great demonstration flights from England.

I mentioned that there was one exception to the lack of air services in the Dominions and Colonies. In the spring of this year the Bermuda and West Atlantic Aviation Company inaugurated a service in the Bermudas with Supermarine flying boats and Avro seaplanes, and more extensive schemes are under consideration. The Government of the Bahamas has passed an Act regulating air navigation, but this is superseded by the new Imperial legislation which, with necessary modifications, includes the Crown Colonies.

Part II.—Factors Contributing to Successful Air Services.

Safety and reliability.—I now propose to consider what is being done and what it is hoped to accomplish in the near future towards the improvement of some of the factors contributing to the successful operation of air services. Our watchwords must be safety and reliability; speed can be improved when these have been attained. Without safety and reliability neither can the public be expected to utilise air transport, nor is there any inducement to surrender mails and other freight for carriage by aeroplane. All transport is liable to accident, but usually from causes unconnected with the actual operation of the vehicle. The safety and reliability of aircraft must be made equally sure with regard to construction and mechanical operation.

The Accidents Branch of the Civil Aviation Department conducts investigations into all serious accidents brought to their notice, and reports on the causes of such accidents, enabling any experience gained to be given general application. This work has been carried out since the Armistice without specific obligation imposed by Statute, but with the invariable good-will and co-operation of the aircraft trade and of aircraft owners. Certain necessary co-relative powers are, however, lacking, and the Air Navigation Bill now before Parliament will remove such disabilities by making obligatory notification of accidents involving serious injury to occupants, or serious structional damage to aircraft. Power to summon witnesses and publish reports, the right of access to and, if necessary, removal of damaged aircraft for investigation purposes is also sought. Every effort, is, in addition, made to reduce the number of accidents which may arise from the personal factor. Experience has shown periodical medical examination of pilots to be essential. There is a medical adviser to the Controller-General of Civil Aviation and an examination, conducted by a specialist medical board, is held every six months, with additional examinations intermediately in the event of illness or accident.

Apart from weather, the safety of an aircraft depends largely upon its engines, and, perhaps, even more upon their installation and accessories, the petrol, oil, water and ignition systems. During the earlier stages of the war the average life of an engine before complete overhaul was necessary was, of stationary engines, from 50 to 60 hours, and of rotary engines, about 15 hours. To-day, these figures stand at 200 hours and upwards and from 50 to 60 hours respectively. Increase in reliability may also be furthered, either by using a very light power plant per horse power, run normally at about half its maximum or by using a plant of greater weight, more solid construction, and greater efficiency, running at nearly its full horse power. The former method is more expensive in primary cost and upkeep, but allows of higher performance and provides reserve horse-power for emergencies; the latter is cheaper but involves a certain risk owing to lack of surplus power in emergency.

The safety devices which are of special utility for commercial machines are those which seek to overcome the possibility of fire in the event of an accident, and those, such as devices for varying the lift of the wings, that seek to lower the landing speed and thus decrease the dangers attendant on forced landings. The machine must be so constructed that the parts, such as magnetos and filters, are easily accessible for inspection. Another important factor is the careful and efficient testing of material; metals, especially valve steels and light alloy castings, timber, glue, fabric, dope, &c. The use of X-rays in discovering flaws in timber has already proved valuable. Incidentally I would strongly urge that the present general system of starting the engine by turning the propeller by hand is entirely antiquated and should no longer be tolerated. It is answerable for approximately 10 per cent. of service accidents.

The all-metal machine affords certain advantages in obtaining safety and durability, especially in tropical climates. The high quality of the material is better assured and the strength and lightness of spars are greater. The chief difficulties are the control of heat treatment,

* Abstract of paper read at the Air Conference, London, Tuesday, October 12, 1920.

corrosion and possible danger of fatigue. A British example of all-metal construction was recently exhibited at the Olympia Exhibition by Messrs. Short Brothers,* but in this respect the Germans have taken the lead. The Junker machine, which has high-lift wings built on the cantilever principle without external bracing, has made several successful flights in America and Sweden. This important development is not being lost sight of in this country.

Safety and reliability secured, we must increase the speed of aircraft upon which rests the superiority of air over other means of transport, and which will assist in overcoming adverse weather conditions. The root of the commercial air transport problem is to discover the best compromise between speed and weight-carrying capacity. Any improvement in wing design naturally improves performance in this direction, and it is to wing efficiency that British designers are paying special attention. The high-lift wing favoured in Germany sacrifices total efficiency to lift; in England experiments are being made to overcome the difficulty (1) by providing a device, as in the cases of the Handley-Page and Fairey wings, which enables the lift to be increased, as in starting and landing, without the efficiency of the wing in normal flight being impaired; and (2) by so designing the wing as to give high lift without the consequent loss of efficiency, as exemplified by the "Alula" wing. In addition to wing design, we must continue to give deep consideration to the development of some form of helicopter, a device not only invaluable for the machine itself but also for many other reasons such as the reduction of the size of aerodromes and their distance from town centres.

In estimating the factors making for safety, reliability, and regularity, we must take into consideration the importance of the timely issue of weather forecasts, devices for "direction finding" by wireless in cloudy and misty weather, a subject to which I shall recur, and last, but by no means least, the human element, the efficiency of the pilot and ground engineer.

Use of different types of aircraft.—One often hears the subject of aeroplane versus airship discussed. It is quite true that each type of aircraft possesses some advantages which the other lacks. The airship can, without refuelling, carry a greater weight a far greater distance than the aeroplane; for instance, it is within the power of the modern airships to fly to Egypt and back without landing, with a load of 20 tons; it can fly day and night, and is not so handicapped by fog and bad visibility; it possesses six engines on which running repairs can be made in the air. The aeroplane, on the other hand, has a much greater speed and even if the mooring of airships to a mast proves effective, will probably always be much more easily landed, housed, and overhauled. The problem, however, is not one of rivalry but of co-operation. The heavier-than-air craft is undoubtedly the best type for journeys which can be undertaken within the hours of daylight, the airship for journey of such length as to involve day and night flying.

Types of aircraft, the development of which is of particular importance to us as an island State are the seaplane, flying boat and amphibian. These will be very valuable, for instance, for services between the United Kingdom and the Scandinavian States or the North German ports. It is not unlikely, in my opinion, that in the future the aeroplane, the seaplane and the flying boat will yield much of their sphere to the amphibian, early types of which have recently undergone successful trials in the Air Ministry Competitions.†

As mail, goods or passenger services extend their radius of operation over country possessing variable characteristics, the type of aircraft best adapted to each section of the route has to be considered and a system of relays established. Differentiation of types is required in accordance not only with the distance and natural characteristics of the route, but also with the nature of the freight carried. Whether aeroplane or airships, seaplane or amphibian is used, each will gradually tend to be subdivided into mail, goods, and passenger carriers. The special requirements for the first are speed, for the second, weight-carrying capacity, and for the third, speed and comfort. In all, however, the factor of standardisation must also be considered. Standardisation to facilitate, not only maintenance, and the interchange of spare parts, but also to ensure mechanical knowledge in the handling and upkeep of the machines.

Points of general ground organisation.—In order to maintain aircraft in the air, it is necessary to make the organisation on the ground as perfect as possible. There are at present in Great Britain 53 civil, official, and privately-owned aerodromes and 53 service aerodromes, available for civil aircraft in emergency only, and arrangements are proceeding for the provision of landing facilities for seaplanes at a number of British ports, and at French, Dutch and Belgian ports where continental traffic is concerned. The new Air Navigation Bill gives power to local authorities to acquire and maintain aerodromes, a provision of which they will, I hope, avail themselves as air traffic increases. The nearer to centres of population aerodromes are situated, the greater the saving in time that is effected. Under present conditions landing grounds for aeroplanes are necessarily located some distance outside large towns, but we are trying to devise a scheme by which large rivers flowing through towns may be used for landing seaplanes and amphibians, thus saving the relatively long journey to the aerodrome. Negotiations are in progress from which it is hoped that the Thames may be used for this purpose.

A problem of considerable difficulty is the ground organisation for night flying. It is obvious that as soon as night flying is practicable the flying capacity of the aeroplane will be doubled. Aerial lighthouses have been in operation for some months at Biggin Hill and Croydon, another will shortly be located at Lympne, and a third between London and Folkestone. Other civil Government aerodromes will be equipped as soon as night flying is practicable. Permanent electric landing lights and lights marking buildings are being installed, and experiments are being made in the use of a searchlight for showing up obstructions on the aerodrome the illumination of wireless towers and flood lights.

Another important factor in the organisation of air navigation by night, and in fog or mist, is the installation of an efficient wireless direction finding and wireless telephonic system. The direction-finding apparatus installed at Croydon enables aircraft to correct their course at night, or in thick weather, and I would take this opportunity to impress upon aviation transport firms the great importance in the interests of safety and regularity of every commercial machine being equipped with wireless. A machine thus equipped with directional wireless can ask for and check its bearings as often as necessary. An interesting instance of the value of wireless telephony was afforded recently when an aeroplane with 10 passengers on board which was forced to land at St. Inglevert after dark was able to ask for landing lights from the air. By a combination of wire and wireless it is now possible to speak from an aeroplane to an office in London via Croydon, and *vice versa*. Wireless stations have also been opened at the civil aerodromes at Castle Bromwich, Didsbury and Renfrew, and the number will be increased as the need arises. The time required for a wireless message to pass between the sender at the London terminal aerodrome and the recipient at Paris has been reduced to an average of 10 to 12 minutes. British proposals for the new International Radio-Telegraph and Telegraph Convention, which are being laid before the International Conference at Washington, include those connected with all forms of communication to and from aircraft.

While on the subject of navigation, I may point out the necessity for the continual improvement of all forms of navigating instruments. It is safer, in many circumstances, for pilots to fly by compass than by the ground, and they must train themselves to work by compass to a much greater extent than they do to-day. By arrangements made with the Society of British Aircraft Constructors, all compasses used by passenger and goods aircraft are to be certified by the Admiralty compass observatory. A compass-swinging base has been constructed at the Croydon aerodrome, and expert advice in the fitting and adjustment of compasses is placed at the disposal of aircraft companies.

Meteorology.—The safety and regularity of air services are largely dependent upon accurate meteorological reports and forecasts, which give the pilots confidence and enable them to circumvent adverse weather. The forecast service of the Meteorological Office in the Department of Civil Aviation, issues hourly reports and short period forecasts for the requirements of the moment; it issues four times daily forecasts covering 24 hours, to assist in making arrangements beforehand, and it issues synoptic messages which give a bird's-eye view of the weather conditions over the whole country, and enable continental and local meteorologists to anticipate the coming weather in their respective areas. The organisation of the system of local centres, specially charged with the distribution of information, was commenced towards the end of 1919. Ten out of 20 of the projected stations are already in operation, three of them being primarily concerned with the provision of reports and forecasts for the London-Paris-Brussels-Amsterdam services. For points along these routes information is supplied of the surface wind and the wind at 2,000 ft., of the amount and height of any low cloud, of the visibility and the prevailing weather, and, for seaplanes, of the state of the sea. Collective reports are issued hourly by wireless telegraphy from Croydon aerodrome, together with forecasts for the remaining period of daylight, and copies of these reports and forecasts are distributed to air transport companies and to others concerned. As a result of international agreement, similar reports are issued at Paris, Brussels and Amsterdam.

A knowledge of the upper air is of fundamental importance in the preparation of accurate forecasts and the use of aeroplanes for determining the conditions above the surface of the earth at certain representative places, has become a regular part of observational work. At all standard stations the measurement of the speed and direction of the wind at different heights is made two or three times daily by means of pilot balloons observed with a special theodolite. On occasions the balloons are followed to very great heights—from 50,000 to 100,000 ft. The examination and classification of the results of these observations is a task of considerable magnitude. It is important, both for the development of the science of meteorology, and for application to commercial services of aeroplanes and airships. Meteorology is largely dependent upon good communications, such as by wireless, and the communications branch of the Department of Civil Aviation is able to give much assistance. The introduction of wireless telegraphy and its wide adoption by the mercantile marines of all countries, has also provided means for placing at the disposal of the meteorologist the observations over the sea for use in the preparation of forecasts, and for the guidance of flights over long stretches of open water, such as those in contemplation to the Scandinavian States. The equipment of lightships with wireless may in the future provide further assistance in this direction.

A feature of meteorology which is often overlooked, is its economic value. By making use of a knowledge of the wind at different heights, aircraft can complete journeys more quickly than would otherwise be possible, and can thereby save their own fuel and their passengers' time. This will be specially useful in the tropics where the regularity of the surface winds has its counterpart in the upper air, but even in Europe time-tables can be drawn up with due attention to the favourable or unfavourable effect of prevailing winds.

Economic and financial factors.—Speed must be paid for and for some time to come the charges for air transport must be higher than those for other forms of transport. On the other hand, from the point of view of the public, the present charges are undoubtedly high, and it is an open question whether commercial services will materially increase the volume of goods and passengers carried until a reduction in price can be effected. It is the old problem, whether to reduce rates to increase traffic, or to wait for increased traffic to reduce rates. It is, however, very difficult to estimate costs at the present stage of development when the volume of permanent traffic and the cost of depreciation over long periods are still undetermined factors.

A severe handicap to the reduction of rates is the rising price of petrol fuel, and to place aviation on a firmer economic basis, we must discover a fuel which, concurrently with ensuring in the interests of safety the least chance of inflammability in itself, and in its installation, gives the greatest possible power for the smallest possible consumption, and which is sufficiently light to allow of a considerable reduction in the weight of an aircraft load, especially on long journeys. Concurrently with the improvement of fuel, the engine must be developed so as to ensure its most economic use. It is quite possible we may eventually have to replace the petrol by the steam engine.

A problem which often comes up for discussion is "What assistance should be given by the State to commercial aviation?" In France the question has been answered by a liberal grant of subsidies, each of which is divided into four parts, (1) for amortisement and upkeep, (2) for the crew, (3) for weight carried, and (4) for military value. It is stated that the subsidy will be granted to "legally constituted air navigation companies carrying out regular services of public value," but the criticism might be made that its practical effect is to give financial assistance to any company maintaining machines in the air without sufficient regard to the value of the work done, or the commercial utility of the machine employed. In fact, a fourth part of the subsidy encourages machines of military utility and therefore tends to counteract the development of a purely commercial type.

In England, on the other hand, the State provides indirect assistance by assuming responsibility for the organisation of aerodromes, wireless and meteorological services, by the adjustment of international questions, by research and experiments. Civil aviation has no great stimulus, such as the war in regard to military aviation, to assist its development and to overcome initial difficulties. British policy is based on the theory that new industries, in order to encourage a healthy growth, must be self-supporting, and is therefore traditionally opposed to giving them direct financial assistance. You will remember, however, that the Advisory Committee on Civil Aviation, in their Report came to the conclusion that in spite of the indirect assistance provided, the development of civil aviation might stop short. The more experience we get, and the more I consider the case in regard to the scheme of subsidies we recommended, the more clear I am that those recommendations were sound. It was shown in our report that for reasons of geography and climate the conditions were unfavourable to the growth of air transport within this country. It was shown that, on the other hand, services to the continent would afford very valuable experience and data upon which to build future Empire air lines. To my mind a healthy air transport industry will assist a healthy constructional industry, which in its turn will be of great value to military aviation. Appreciative as I am of the arguments in favour of allowing industry to stand on its own feet, I am strongly of opinion that civil aviation must not be allowed to die for lack of direct assistance, the need for which would only be temporary. That is to say during the period—two to five years—during which old material is being used up, and whilst new and really suitable types are being evolved. Without this small stimulus, I feel it will be very difficult for transport concerns to show enterprise and vigour even if they can live during the next year or two.

The last subject which I shall touch on under this heading of finance and economy is insurance. Under modern conditions insurance is closely interwoven with all human concerns to which any element of risk attaches, and every country interested in aviation is endeavouring to work out a sound and equitable insurance scheme. In France a Consortium of Insurance Companies has been formed and insurance, for which a detailed scheme has been drawn up, is being made compulsory by the State. The French subsidy scheme involves considerable supervision of aviation companies by the State, and this may tend to State control of insurance. Aviation insurance has also been actively taken up by the Scandinavian Insurance Pool, which consists of 89 affiliated companies, and aims at becoming the Lloyds of the aircraft world.

In England our policy is to encourage insurance as far as possible to take its normal course. At present, however, insurance companies are handicapped by a relatively small field of operation, lack of machinery and experience. At this stage, therefore, the responsibility for inspection, licensing, certificates, &c., devolves entirely upon the State, which, however, hands on to insurance companies all the information available which may affect insurance and assist them to operate. For instance, the Government at present inspects ground engineers, who receive their salaries from the aviation companies. It is hoped that with the expansion of air

* See page 78 *ante*.

† The results, as officially supplied, are published in another part of this issue.

transport and as soon as the insurance world is in possession of fuller information and gains the necessary experience, they will assume a great deal of the work of inspection at present carried out by the State.

Carriage of mails.—Without minimising the importance of goods and passenger traffic by air, in my opinion, the carriage of mails is the basis on which commercial aviation must at present develop. Aircraft has revolutionised the speed of intercommunication by letter; and banks and financial houses are beginning to realise that large savings can be made by utilising air mails for the transaction of business. We should approach the question by considering, not what mails can, but what mails cannot, be carried by air. The area of the British Isles is not very favourable for an extensive air mail service, which can only operate by day, since by the existing means of transport mails are carried during the out-of-business hours and can generally reach their destination in a night. This is another reason why it is highly important to solve the problem of regular night services. On the air services to the continent, on the other hand, a great saving in time is effected, and I should like to see a very material increase in the amount of mails thus carried, with the ultimate result of the carriage of *all* mails by the certified continental air services at normal rates.

I have already described the extensive scheme, which is being tried out, apparently with considerable success, in the United States, where the Post Office authorities state that by carrying all mails on the routes in operation by aircraft, and, although the normal postage fee only is charged, a distinct economy in ultimate outlay is effected. The scheme, like most others at the present stage of development, must be regarded as experimental, but it is only by large experiments such as this that useful knowledge and experience can be gained; and I therefore submit that as soon as feasible, all letter mails between this country and Paris, Brussels and Amsterdam be carried by air, and carried without additional postage fee.

Part III.—Suggestions for Future Development of Air Services.

In urging the establishment of air services within these islands we must face the fact that commercial aviation cannot enter into competition by day only with an efficient day and night express railway service, such as is to be found running north and south in England. Possible exceptions might include amphibian services between London and Dublin, accelerating the delivery of mails five or six hours; or between Glasgow and Belfast, where the Clyde and Belfast harbours could be used as the terminals. In continental countries also air transport has to compete against railway systems, but the distances between centres of population and industry are more suited to the operation of air services and the railway network is less perfect than in England.

The position of Germany and Austria is very favourable to the development of air services. Berlin is within a 350 miles radius of Copenhagen, Cologne, Munich, Vienna and Warsaw, while Vienna is in an advantageous situation as the junction for a south European system extending to the Balkan States and the Near East. In the United States the distances are such that aeroplanes flying by day only, can in many cases effect considerable saving of time. The New York–San Francisco mail service, for instance, should save about two days in the delivery of letters.

But though the area of the United Kingdom does not allow of internal long distance flights essential for obtaining the full value from aircraft, its insular position is by no means unfavourable to the establishment of air services to the continent, whereby the sea passage and the loss of time entailed in changing from ship to train can be saved. Until night flying is safer and longer distances can be flown continuously, we must ensure the maintenance of the existing services to the continent and promote others on the same lines. Not only Paris, Brussels and Amsterdam but the Scandinavian countries and the north German ports, and to the South, Spain and Portugal, should be linked up with England by British air services. It is very important, too, that the British aircraft construction industry should supply machines, not only to British, but, where permissible, to foreign commercial transport companies, in order to expand and obtain a proper outlet for their production.

We have, however, to consider commercial aviation, not only from the continental, but from the Imperial, point of view. Here we have the long distances favourable to aircraft, but England is detached, either by the ocean, or foreign territory, from the nearest Dominion or possession. In the one case the range is too great for aeroplanes, in the other they are dependent on foreign landing grounds. The key-routes in the Imperial system are those from England to Egypt, and Egypt to India, and we should see whether the airship is capable of running a commercial day and night service on the former. Even if the airship is successful, we must still develop the long-distance, weight-carrying aeroplane. I personally am in hopes that with encouragement the day is not very far distant when we may see a heavier than air craft, capable of carrying economically 50 to 100 passengers, or their equivalent, and undertaking the trans-Mediterranean journey, with Malta as a stopping place.

The onus of linking up the Empire by air must not rest upon Great Britain alone. Each Dominion and Colony must form its own nucleus of air development and thus help gradually to build up the complete system. There are within the various countries of the Empire considerable opportunities of practical development, and I must touch on a few of these. At present the West Indies are suffering from the lack of interisland communication, both for mails and passengers, and this can be partially rectified by an air service for the Leeward, the Windward Islands and the Bahamas, and between the Bahamas and the American Continent, where an American company has actually conducted a service. I am glad to say that the Bermuda, and West Atlantic Aviation Company is interesting itself in the project. This position in the West Indies appears to indicate the advantage of the British steamship companies considering seriously the value of supplementing their services by air. Large rivers are adaptable to flying boat services, especially as they have the great advantage of visibility by night, and the consideration of a project for such a service on the Nile was only given up owing to the disturbances in Egypt. A practical scheme is also under consideration for an air service from Melbourne to Sydney, Adelaide and Hobart in Tasmania. The distances between the various stopping places are not so great as to overtask the capacity of modern aircraft, and should afford an excellent criterion of the value of aircraft as a mail and passenger carrier. These instances, will, I hope, afford some indication of the various methods whereby development may be assisted.

Let us have no illusions about the difficulties confronting civil aviation. Never has the need of national retrenchment been greater, and it is clear that financial stringency will increase rather than diminish. But economy which is blind to the demands and possibilities of progress is no true economy, and I firmly believe that a reasoned policy of financial encouragement towards productive services will in the long run prove an infinitely more profitable investment than others which have taken place. Without such encouragement, the air transport industry, which is yet in its infancy, may wilt, and by reason of the unimaginative correctitude of British policy. Not only may one of those opportunities which do not recur be lost, but we will have to face the almost complete disintegration of the expert designing and construction staffs built up during the war, and the potential loss to the Royal Air Force of what the Mercantile Marine is in emergency to the Navy.

CATALOGUES.

Electric Motors.—A monthly list of motors in stock comes from Messrs. Higgs Brothers, Sand Pits, Birmingham, giving prices and the leading particulars of machines available.

Tools.—A catalogue of taps, dies, reamers, set squares, adjustable mandrels, and small drilling machines has reached us from Messrs. Ira Miller and Co., Limited, 92, Paul-street, London, E.C. 2.

Motor Accessories.—Messrs. Brown Brothers, Limited, Great Eastern-street, London, E.C. 2, send a reduced reproduction of the large general catalogue mentioned recently in these notes.

Electrical Signs.—A large variety of signs and flashers are described in a catalogue received from the Sun Electrical Company, Limited, Neal-street, Long Acre, London, W.C. 2.

Time Recorders.—Catalogues illustrating recording clocks for printing the time on cards and a watchman's tell-tale clock for the 48-hour week-end come from the Thames Manufacturing Company, Limited, Duke-street, London Bridge, S.E. 1.

Flow Meters.—The British Thomson-Houston Company, Limited, Rugby, send a special catalogue of meters for indicating and recording the flow of steam, gas, water, air, oil, &c. The explanatory matter is clearly written and well illustrated.

Oil Engines.—Messrs. Prices' Company, Limited, Battersea, London, S.W. 11, have issued a pamphlet discussing the history and type variations of oil engines, and containing notes on lubrication. A copy will be sent by the company to any one specially interested in the subject.

Dry Cells.—A catalogue of dry cells, and battery units of them, which comes from Messrs. Siemens Brothers and Co., Limited, Woolwich, includes nearly all kinds of portable cells, including "inert" cells which may be stored for an indefinite time and rendered active by adding a little water.

Shearing Machine.—An interesting type of shearing machine having two rotating cutters is described in a catalogue issued by the Quickwork Company, St. Mary's, Ohio, U.S.A. (Agents: The Oliver Machinery Company, Deansgate, Manchester). The machine cuts plates from the thinnest up to 1 in. thick, leaving a square finished edge, and is capable of cutting in curved lines.

Baling Press.—A vertical type baling press operated by an electric motor mounted on the top is described in a special catalogue issued by the makers Messrs. Hindle, Son and Co., Haslingden, Lancs. The power is applied through steel wire ropes working in pulley block fashion at each of the four corners of the press and leaving clear access at back and front.

Rocking Bearings.—A carefully written and neatly printed book with good illustrations explaining the Michell bearings has been issued by Michell Bearings, Limited, 3, Central Buildings, Westminster, S.W. 11. Although these bearings are now so widely used and well understood by engineers generally their makers continue to present a simple explanation of the practical and theoretical aspect of the subject—a policy to be commended in engineering catalogues of all kinds.

Aluminium.—Some useful leaflets of note-book size come from the British Aluminium Company, Limited, 109, Queen Victoria-street, London, E.C. 4, dealing with aluminium sauls for veneering, cast wheels for motor cars and other vehicles, and giving information relating to the alloying, casting and working of aluminium. The aluminium sauls, it may be mentioned, are sheets placed between the planks to keep them separate while in the veneering press.

Oil Engines.—A catalogue of engines using crude oil, but suitable also for refined oils, comes from Messrs. Robey and Co., Limited, Lincoln. These are engines of the vertical two-stroke type and are made in a full range of standard sizes—10 with single cylinders developing from 6 h.p. to 50 h.p., and 10 of the multi-cylinder type developing up to 200 h.p. Some of the sizes are supplied in portable form mounted on strong four wheel trucks. Full and precise particulars of power, weight, &c., are given in the catalogue.

Gas Engine Plant.—Small power plants comprising gas engine suction producer and auxiliaries, designed for very easy and economical working are described in a catalogue received from the Anderson-Grice Company, Limited, Carmoustie, Scotland. Fourteen standard sizes are listed ranging from 7 h.p. to 150 h.p. Much care has evidently been expended in making the plants as simple, strong and accessible as possible. This type of plant, it is claimed, can be operated at about one-fourth the cost of other methods of power production.

Thread Grinder.—A lathe attachment grinder for finishing hardened screw threads is described in a catalogue received from the Precision and Thread Grinder Manufacturing Company, Arch-street, Philadelphia, U.S.A. It consists of a motor-driven spindle and an adjustable tool rest for the diamond tool for dressing the grinding wheel. In one form a vee-edge wheel grinds out the included angle, and in another two wheels operate on opposite sides of the work, each grinding on opposite flanks of the thread.

Cranes.—The catalogue issued by Messrs. Stothert and Pitt, Limited, Bath, shows a very wide range of cranes for docks and warehouses, cargo handling, railway work, forging, shipbuilding and other purposes. All the cranes are electrically driven and have a full equipment of auxiliary appliances. Much useful explanatory matter is given in the catalogue, which also includes a lucid description of the firm's horizontal luffing gear for jib cranes. The catalogue, which extends to over 100 quarto pages is well printed and illustrated and is in every way a creditable example of trade literature.

Water Flow Instruments.—Messrs. George Kent, Limited, 199, High Holborn, London (works, Luton), send a general catalogue of their productions which include venturi meters, domestic and trade standard meters a rotary piston type for district supplies, high-pressure hydraulic flows and low pressure boiler feed supplies, an "inferential" type, audible water level indicators, waste detector meter, vee notch discharge recorders, steam flow meters, air meters, &c. Also a special catalogue giving a long list of venturi meters supplied with short particulars in each case.

Ash Conveying Plant.—A catalogue from Messrs. R. White and Sons, Widnes, describes a large ash conveying plant erected by them some years ago for a Cheshire chemical works. The ashes are conveyed in tipping buckets by an aerial ropeway over 2,000 ft. long at a maximum rate of 15 tons per hour. The buckets are raised by an elevator to a height of 60 ft. and then travelled and tipped and returned into position for reloading automatically. The standards supporting the ropeway are moved from time to time in order to cover the tipping field. Several good illustrations and a clear ground plan are given, and the booklet is both interesting in itself and excellent testimony to the firm's ability to deal with such unusual tasks. Another booklet describes an ore conveying plant having a capacity of 300 tons per hour erected by the same firm at Coatbridge, near Glasgow, and operated on somewhat similar lines.

Radial Drilling Machines.—This machine tool is very adequately represented in several catalogues received from Messrs. William Asquith, Limited, Halifax, who make many special designs and a full range of sizes. The usual type has a base plate with a fixed pillar on which the radial arm revolves and on which it may be raised or lowered by mechanical power, with the drill vertically disposed. As a variation of this design there are several forms of multiple surface base-plates, and base-plates on which the pillar may be traversed; and also forms in which the drill may be swivelled almost universally by turning the arm and saddle. Several portable machines are also made and also a machine of the horizontal type. Fixed, revolving and swivelling tables, angle plates, tapping, reaming, milling and other tools and attachments are shown in the catalogue. Even very heavy machines are easily operated by one man owing to the full application of power to the adjustable parts. A smaller catalogue illustrating examples of machines applied to special work is an interesting summary of the large catalogue.

Tractors for Esthonia.—According to the Esthonian paper *Waba Maa*, for August 27, ploughing tests were made with the International Harvester Company's tractors on August 26, many official persons from the Ministry of Agriculture and local farmers being present. The results achieved showed that the machines are suitable for use in Esthonia, and it is confidently anticipated that the Ministry of Agriculture will place large orders for tractors next spring. In connection with the foregoing, although it is not felt that United Kingdom manufacturers are likely to take any action on account of financial difficulties of trade with Esthonia and the proximity of Germany, the Department of Overseas Trade would be quite willing to offer its services in case any firm is interested.